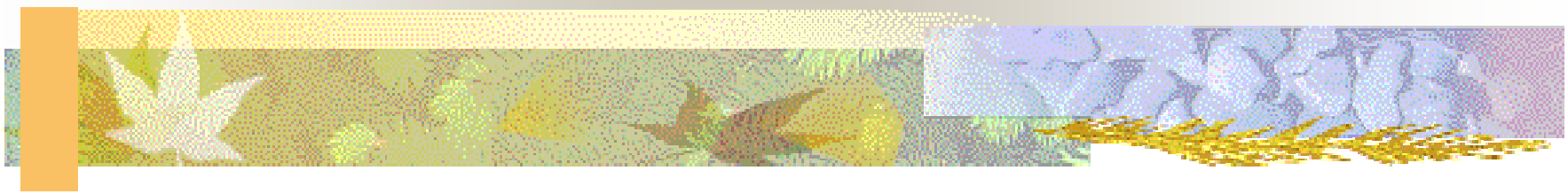
# *Natural Solutions*
## for Water Quality and Storm Water Management



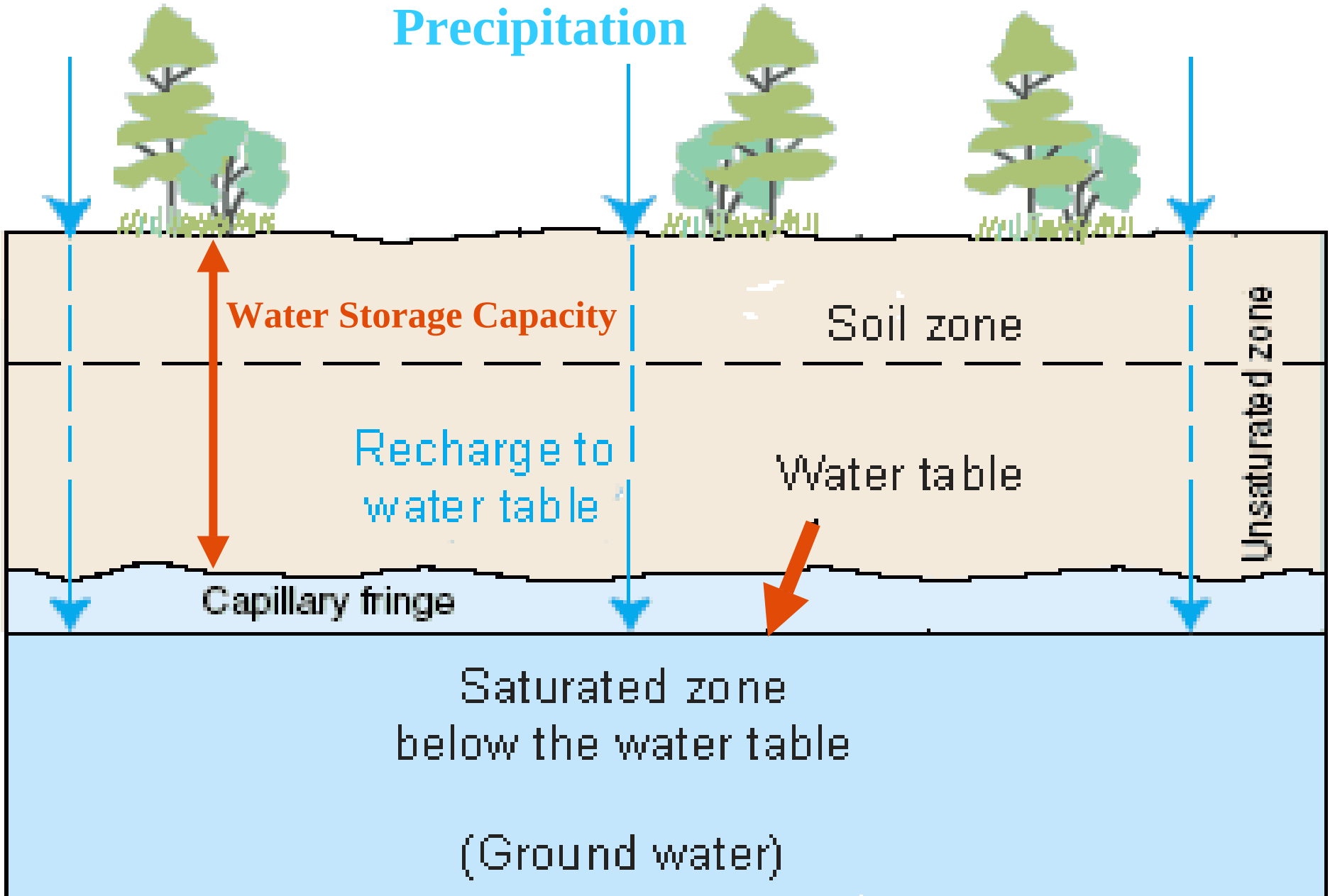
**Tennessee Department of Agriculture**

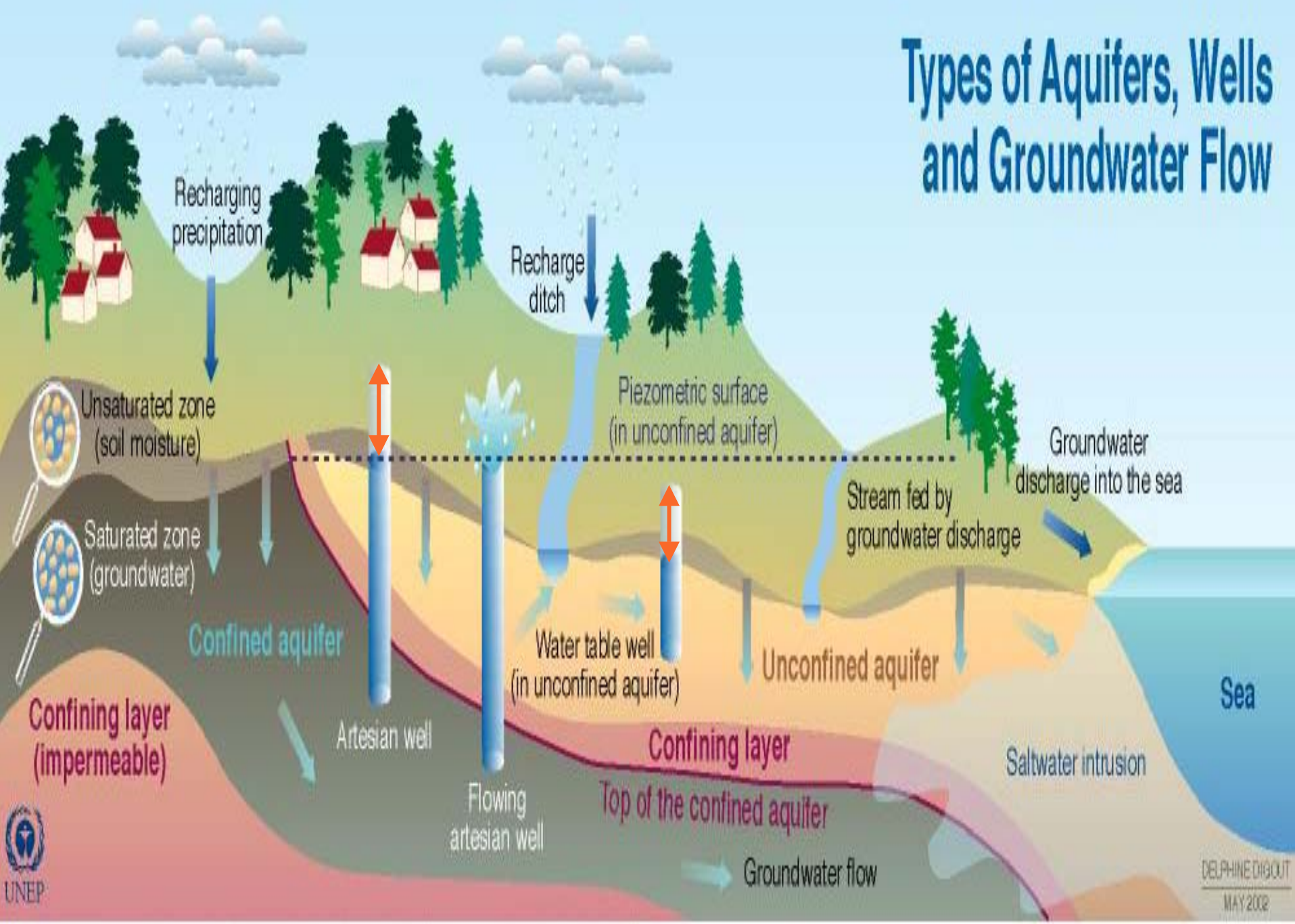
**Water Resources**

# Outline

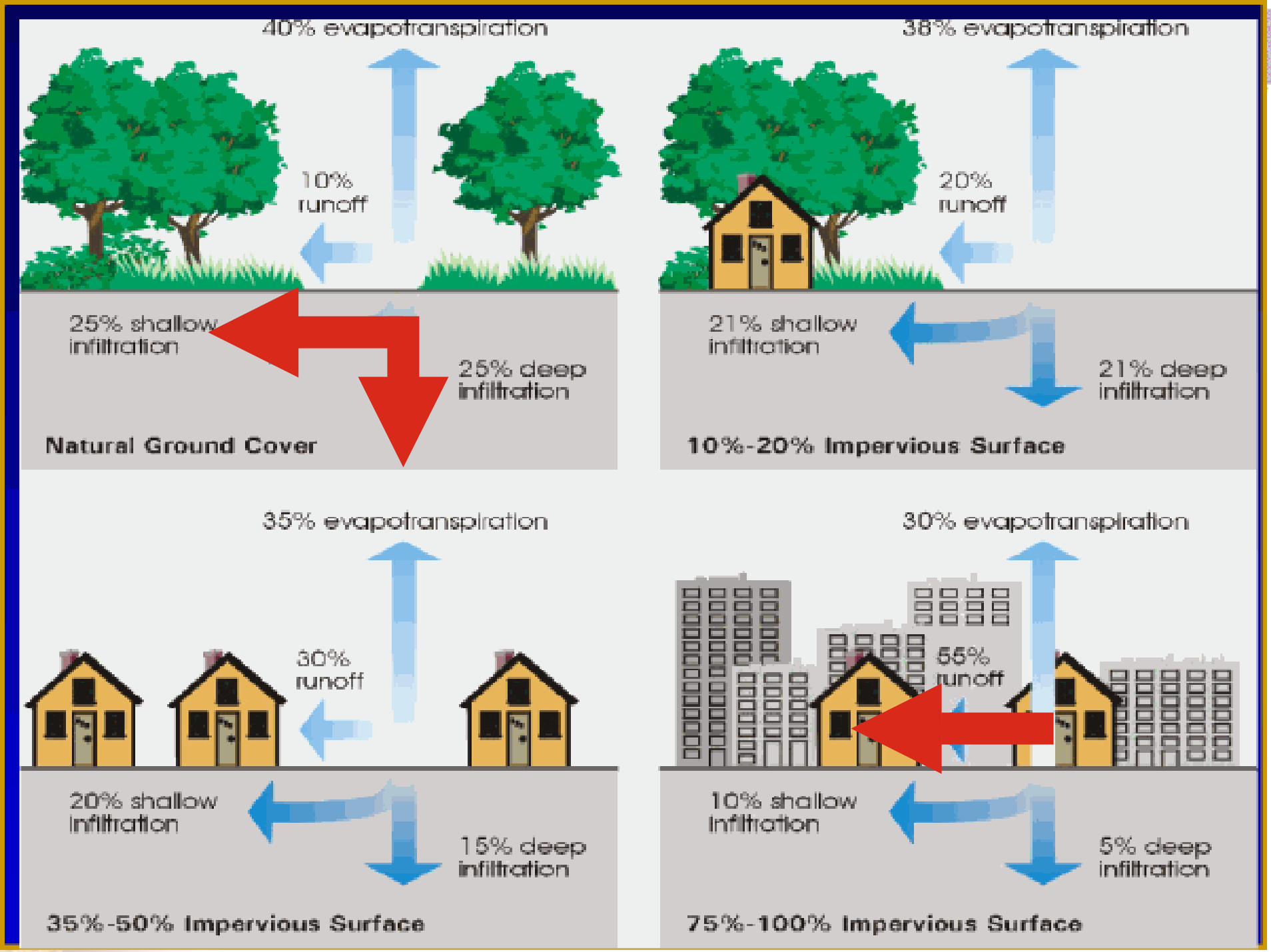
- Same Dynamics: Stormwater & Erosion
- The Basics - Why a new way is needed
- Trends toward *Natural Solutions*
- Examples from around the nation
- Projects at Ellington Agricultural Center

# *The Earth's Surface*: A Sponge, Filter and Savings Account

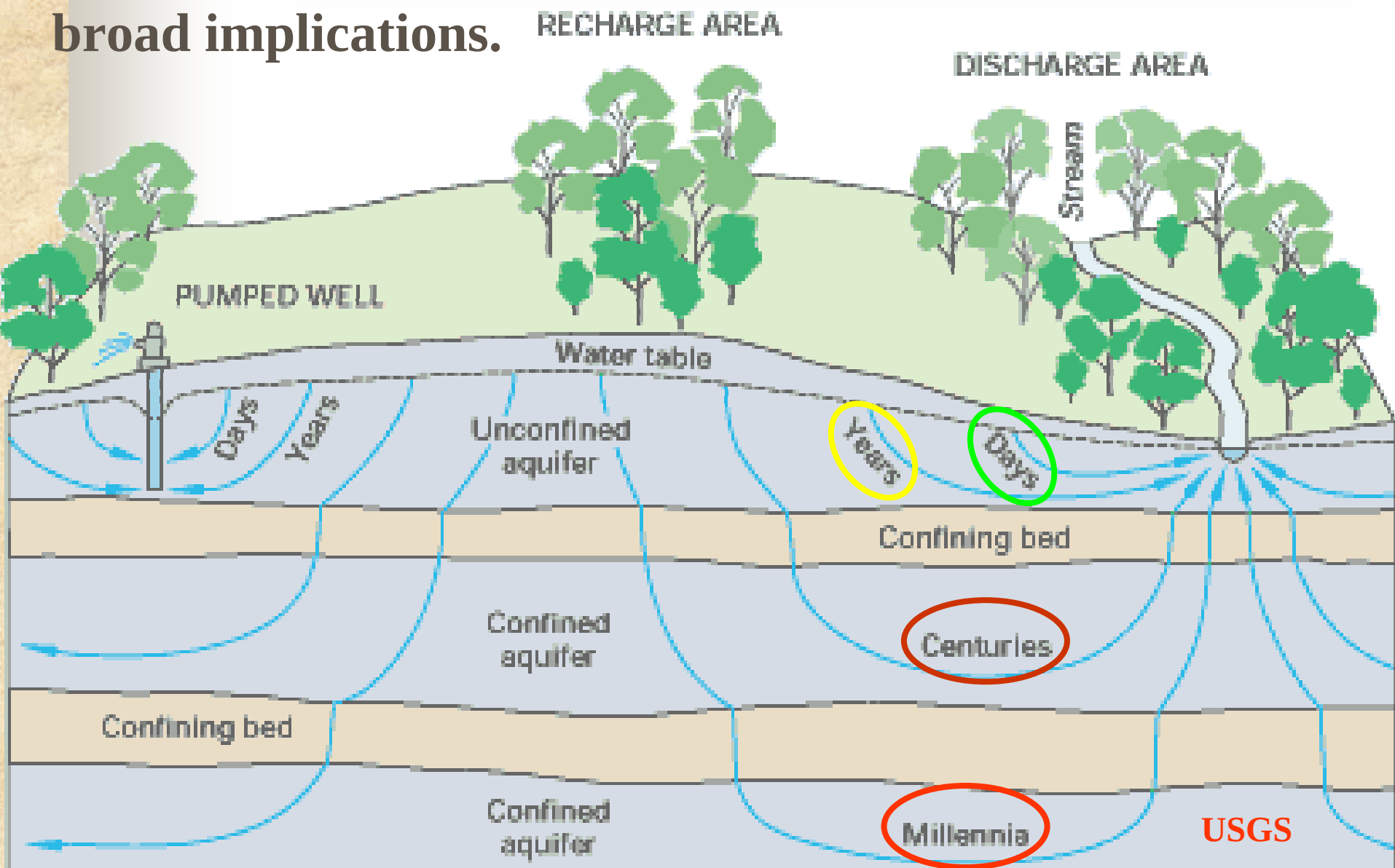




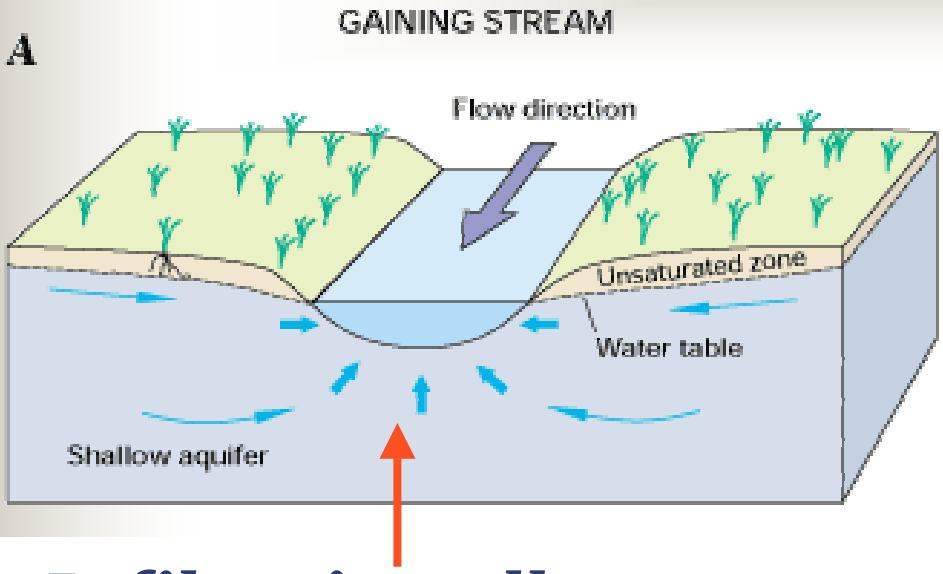

Source: Environment Canada, 2001 (Adapted from: http://www.ec.ca/water/index.htm).


40% evapotranspiration
10% runoff
25% shallow infiltration
25% deep infiltration
Natural Ground Cover
38% evapotranspiration
20% runoff
21% shallow infiltration
21% deep infiltration
10%-20% Impervious Surface
35% evapotranspiration
30% runoff
20% shallow infiltration
15% deep infiltration
35%-50% Impervious Surface
30% evapotranspiration
55% runoff
10% shallow infiltration
5% deep infiltration
75%-100% Impervious Surface

# Infiltration has broad implications.

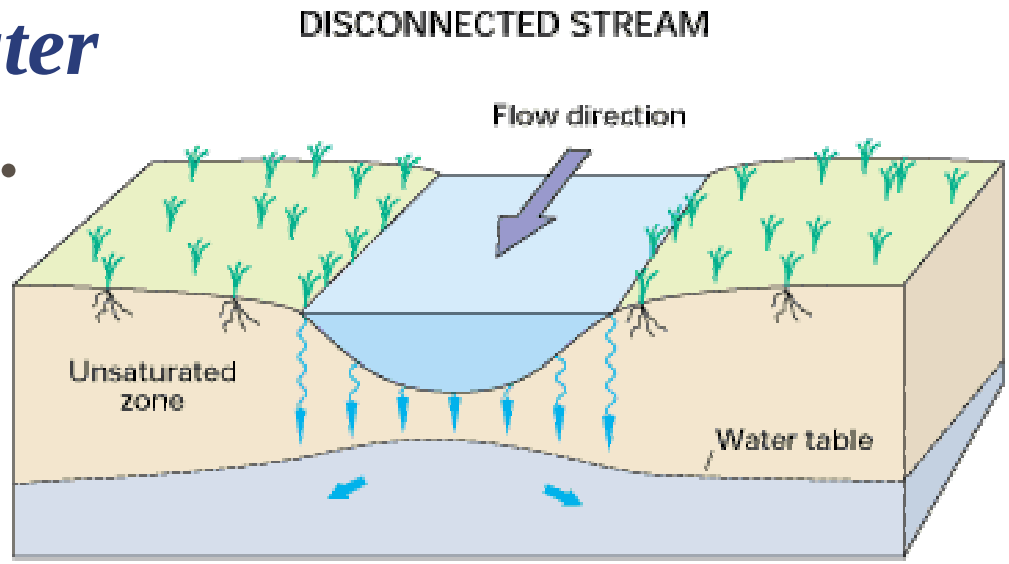


USGS




***Infiltration allows some streams to gain water during droughts.***

***Less infiltration can mean less water for streams.***

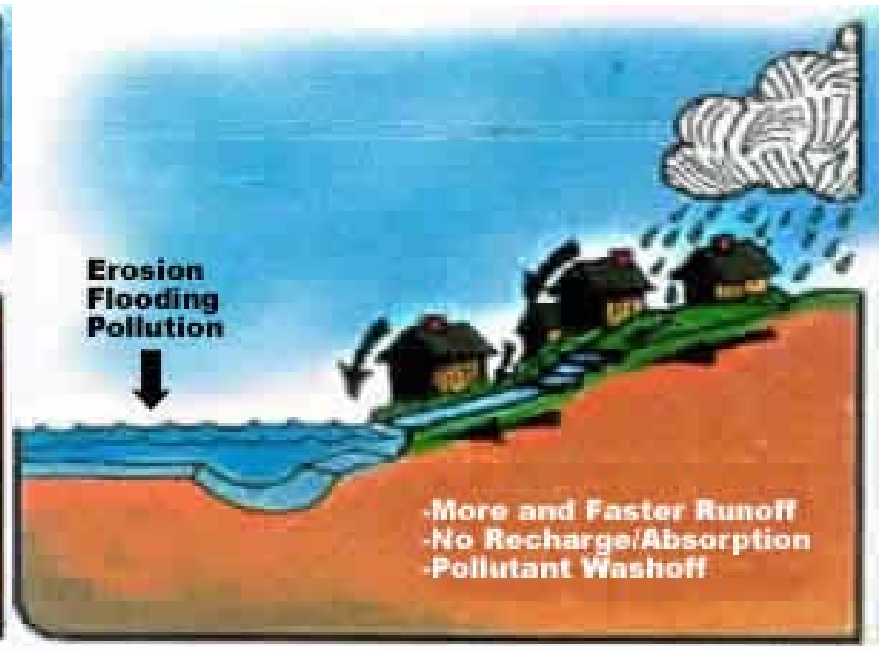


## Natural Surfaces

*Absorb Rain Water*


## Hardened Surfaces

*Repel Water*



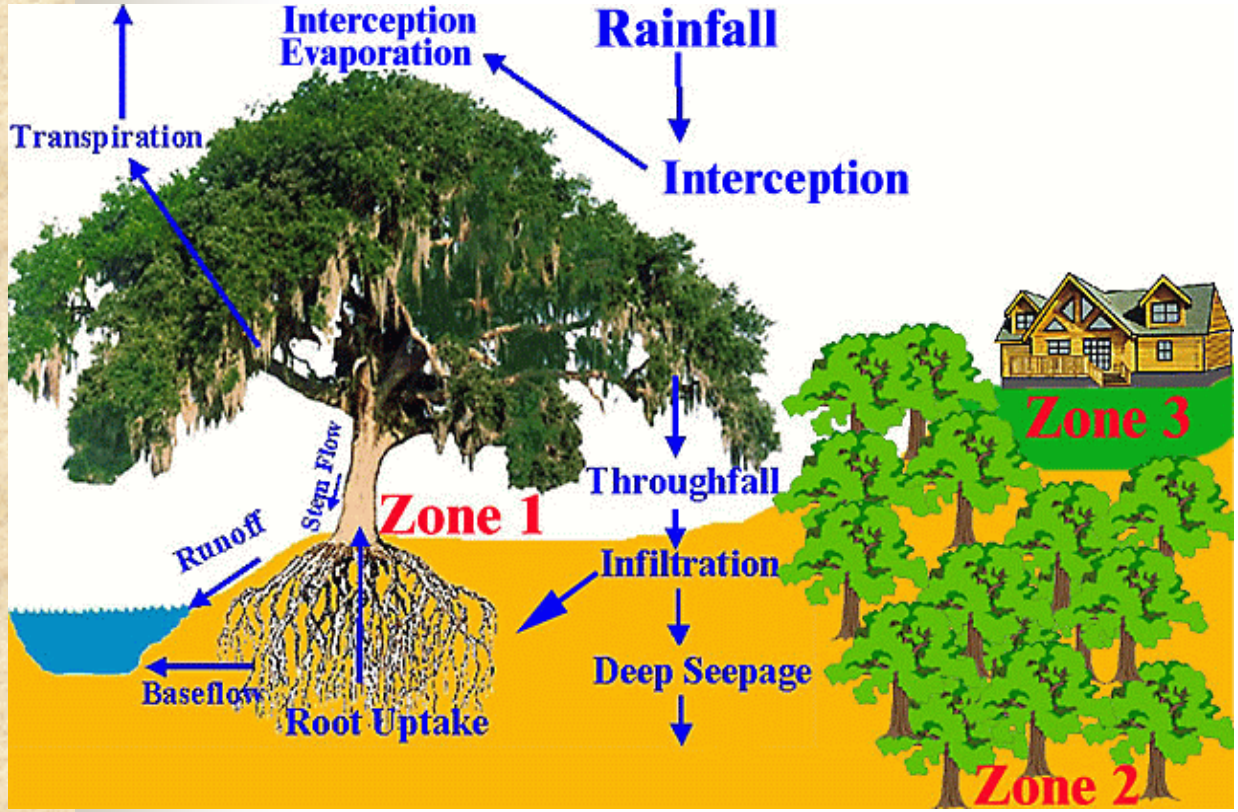

**Smaller Floods**

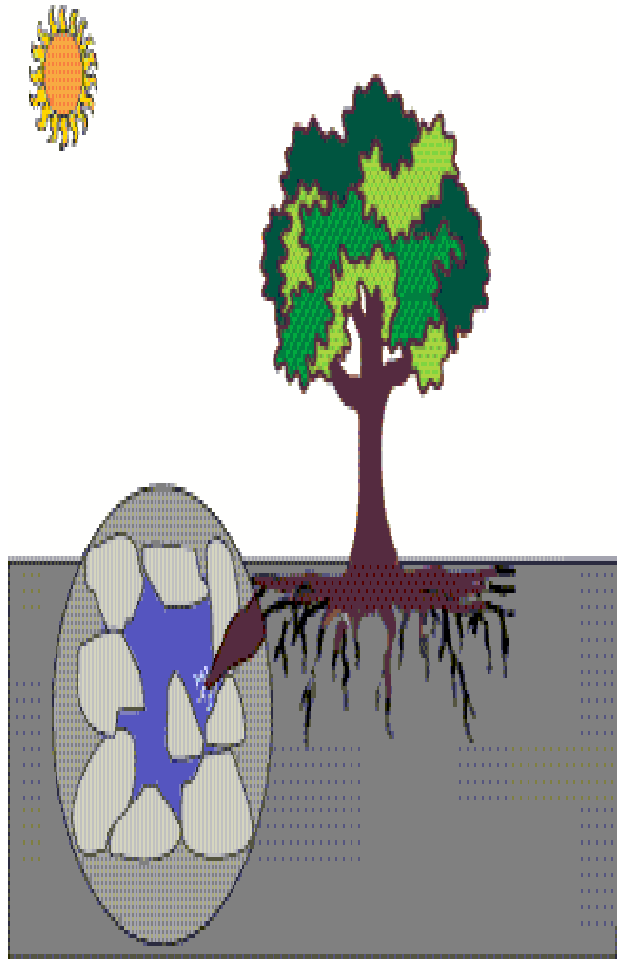
**Cleaner Water**

**Bigger Floods**

**Dirtier Water**

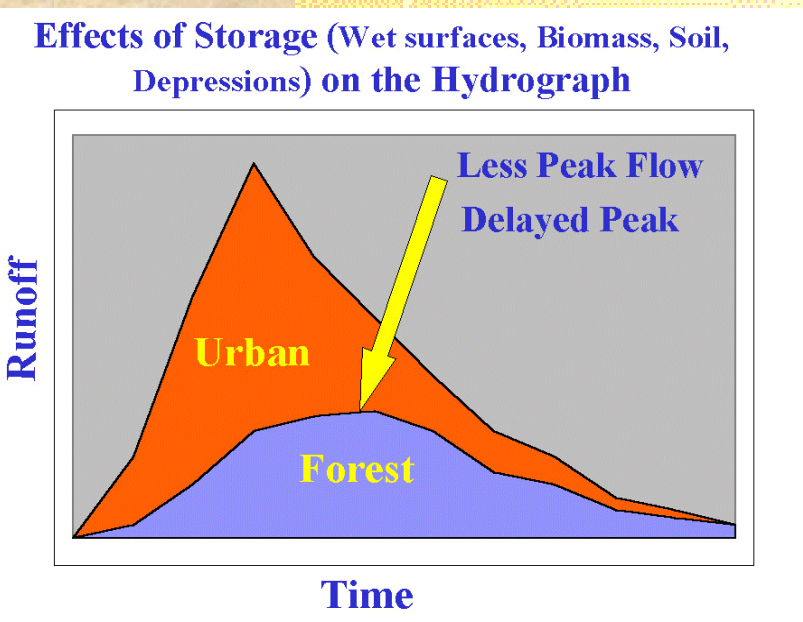
# Trees: Interception and Infiltration

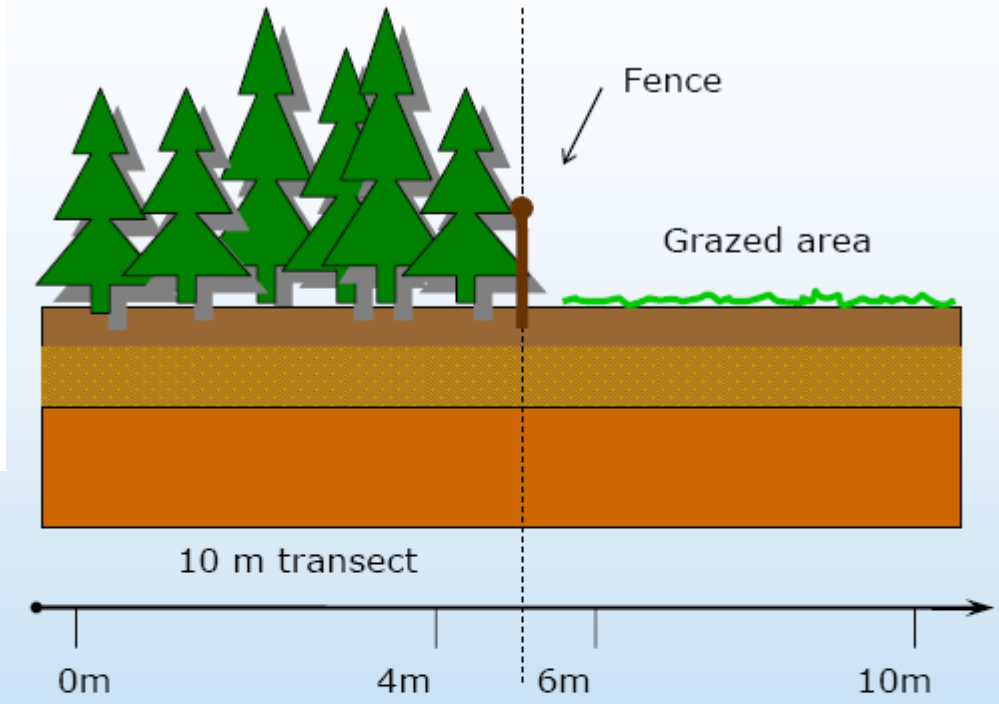


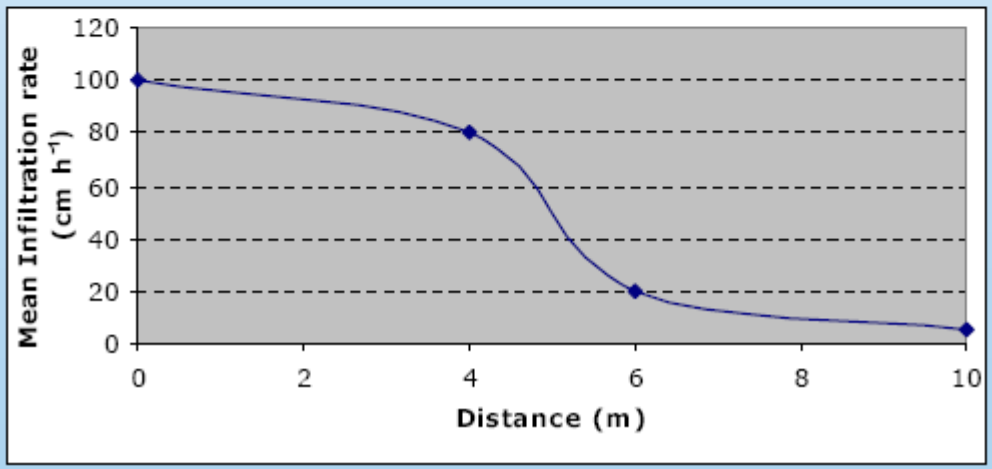
# Trees Mean Less Runoff
# Some Statistics – Univ. of Wisconsin

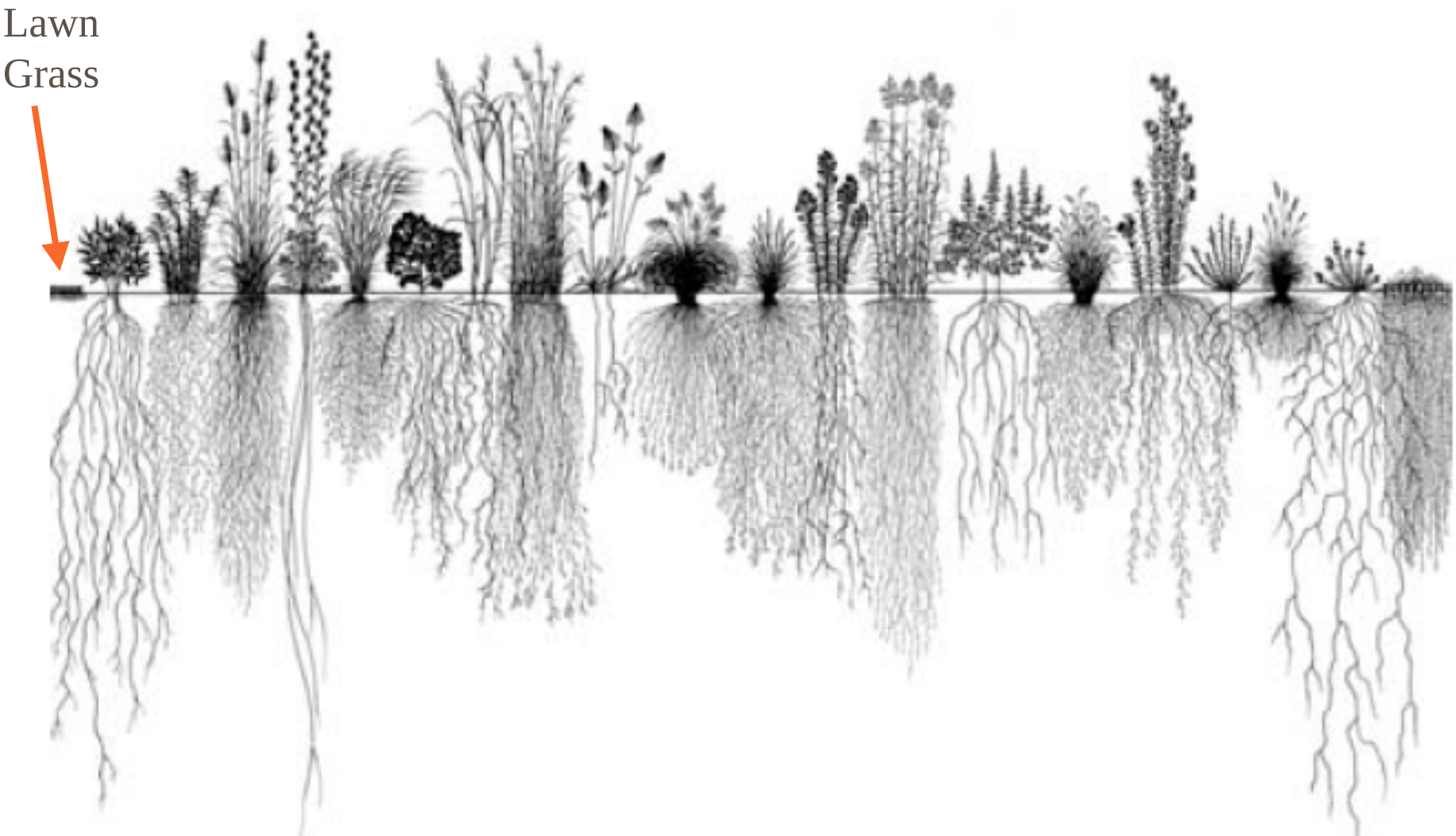
- Fayetteville, Arkansas found increasing tree canopy from 27-40% reduced their storm water runoff by 31%
- South Miami residential study found that a 21% existing tree canopy reduces the storm water runoff by 15%
- For every 5% of tree cover added to a community, storm water is reduced by approximately 2%




# Even in thin soil "retention" can triple






*Deep root systems of native grasses and forbs. Note shallow root system of conventional blue grass turf at far left. Drawing courtesy of Conservation Research Institute,*

# *Fig. 3: Water Infiltration Rates*

| Type of Plant | Rain Absorbed |
|---|---|
| Bluegrass Lawn | 0-2 inches/hour |
| 2-year-old Native Switch Grass | 7.5 inches/hour |
| Mature Forest Undergrowth | 21 inches/hour |

*Data from Luna Bharati, "Infiltration Studies Along Vegetated Riparian Buffer Zones," Iowa State University MA Thesis.*

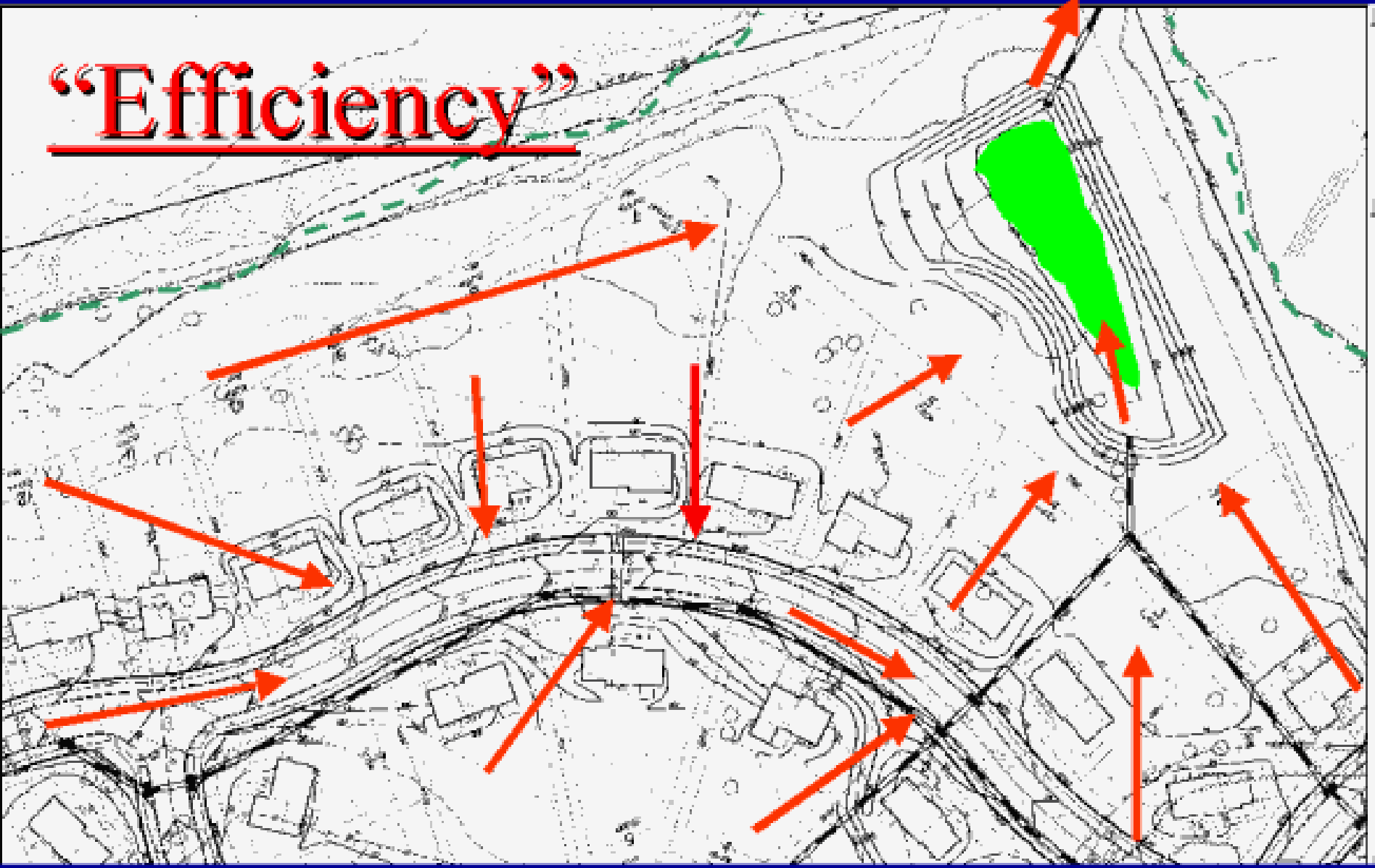
# What has not changed?

# Stormwater management has not improved.

- Shallow roots, mowed riparian zone
- Traditional street stormwater design
- Traditional gutters and disposal

***In short: Move it downstream***

# Conventional Pipe and Pond Centralized Control

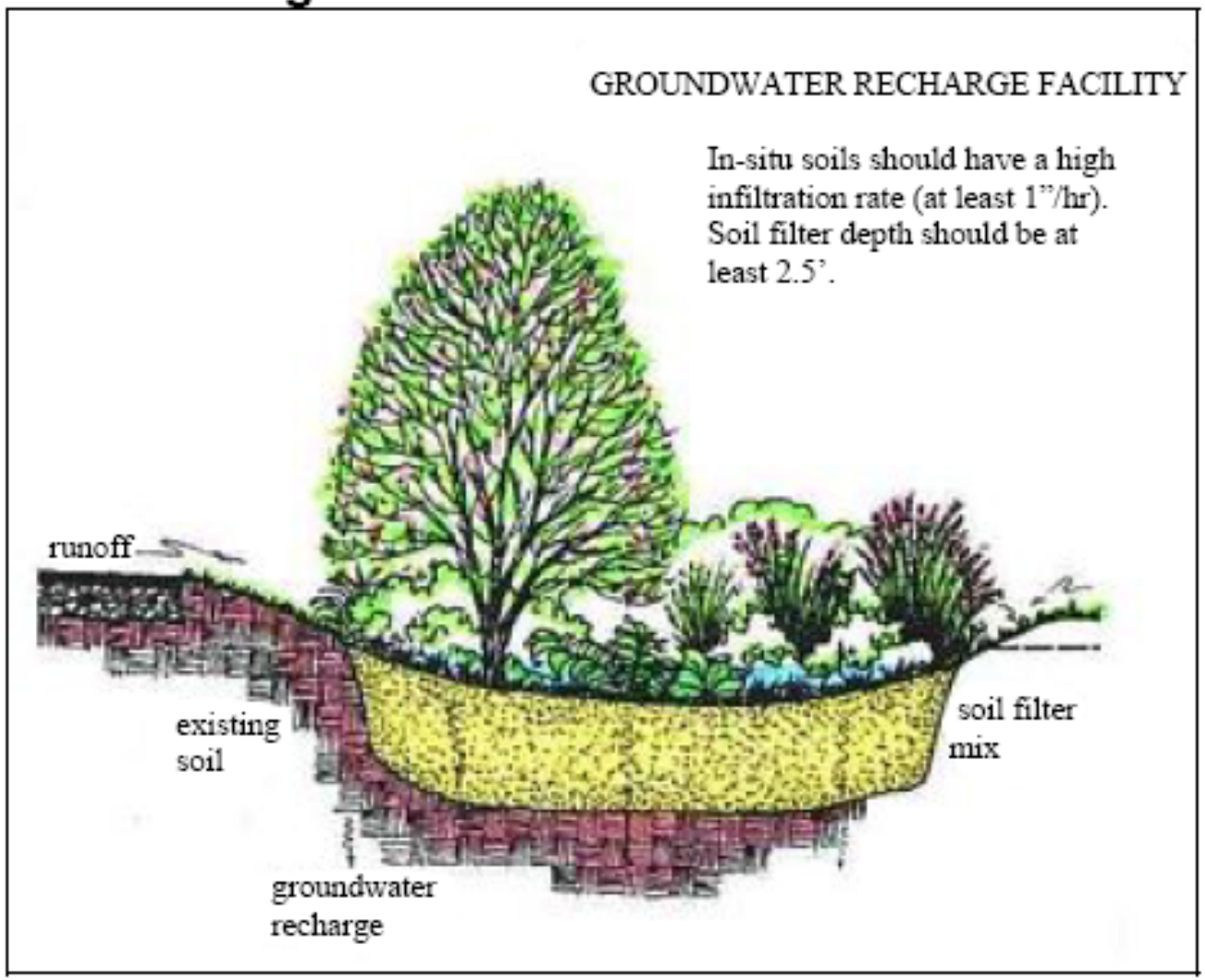


# New Trend: *Decentralized* Approach

## *Quality and Efficiency*


**Somerset, Md - 80 acres**

# Figure 8-2. Bioretention Area

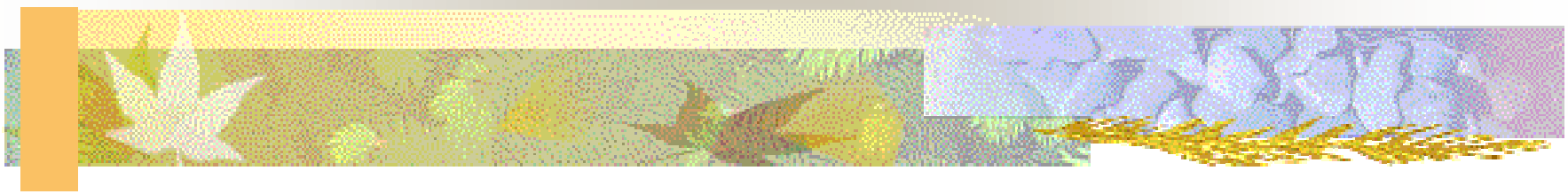



Source: PGDER.

**“One body of disciplines is emerging.”**

***Modern solutions are integrating*** **biology, engineering, soil science, plant science, horticulture, landscape architecture, city planning and other sciences and the arts.**

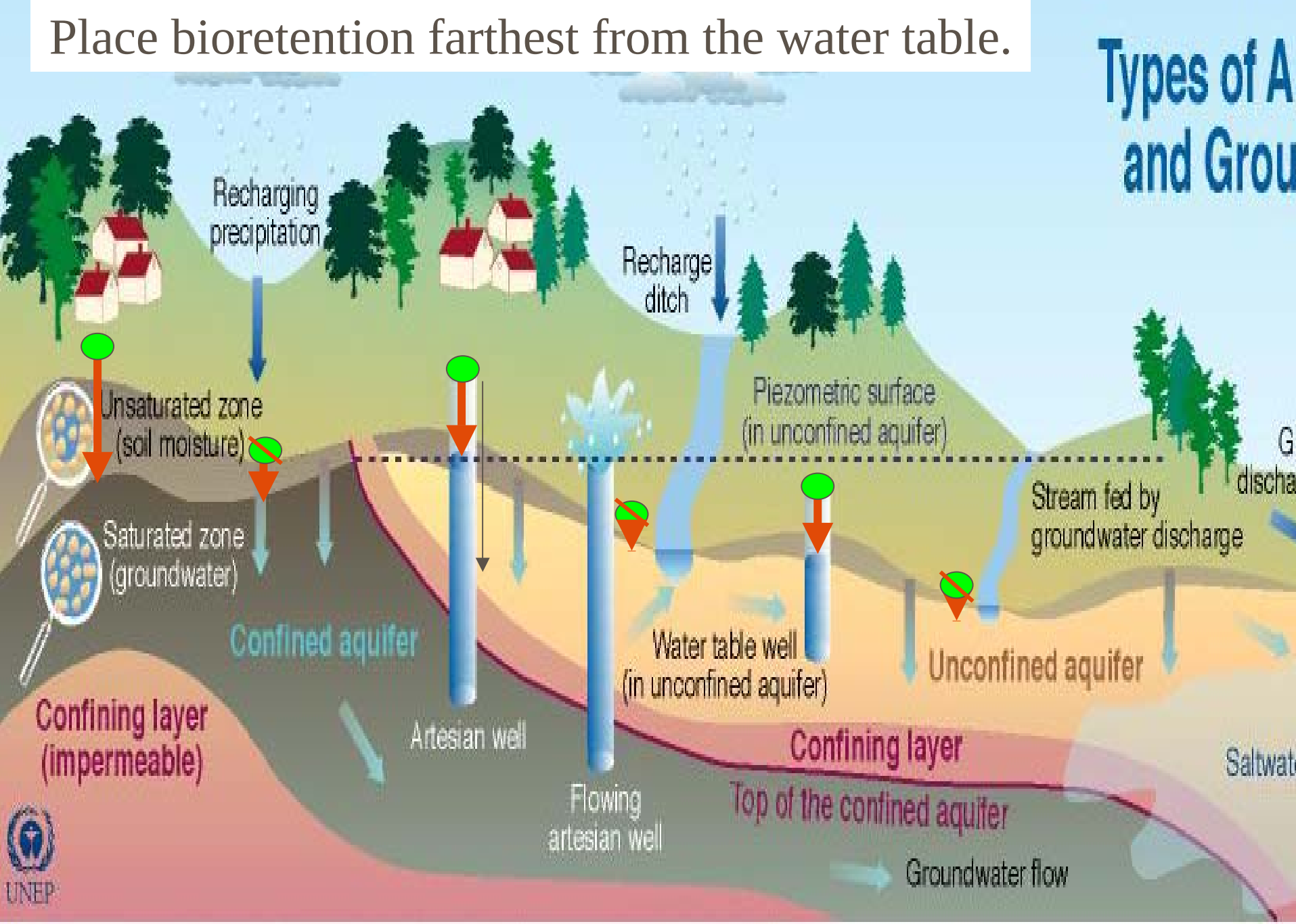
# Residential Scale Bioretention



*“Get er done”*

# Barr Engineering

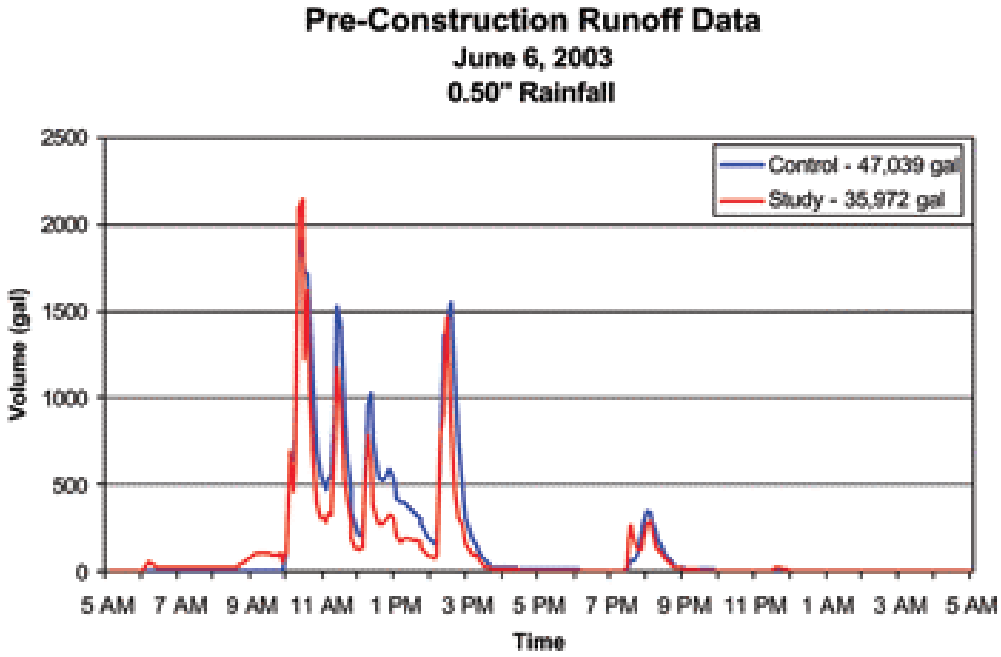
# Place bioretention farthest from the water table.

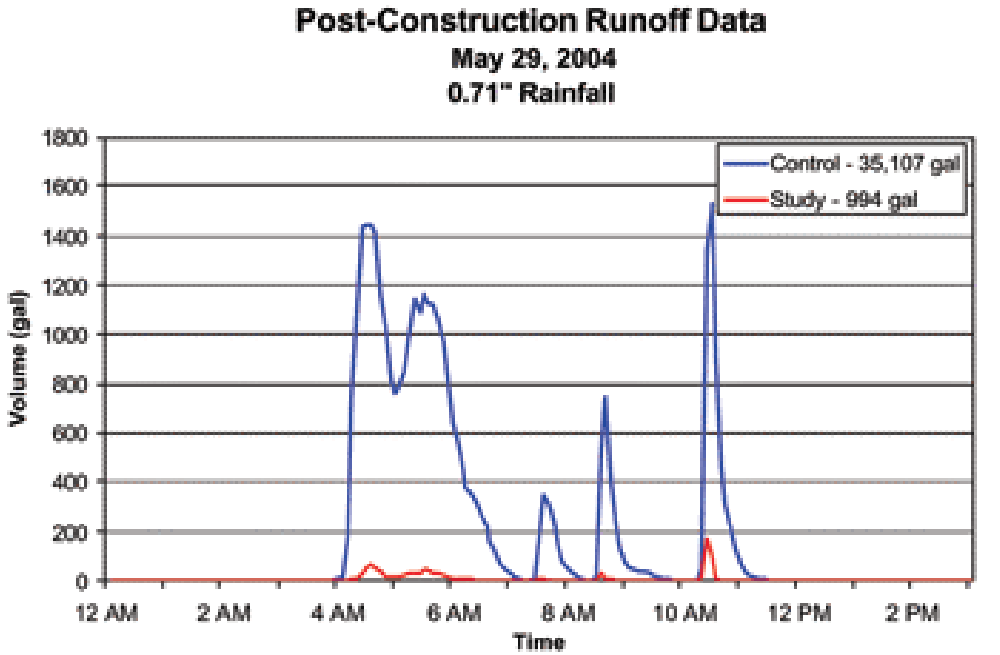



Source: Environment Canada, 2001 (Adapted from: http://www.ec.ca/water/index.htm).

Runoff reduced by 35,000 gallons of water.

90 Percent Reduction



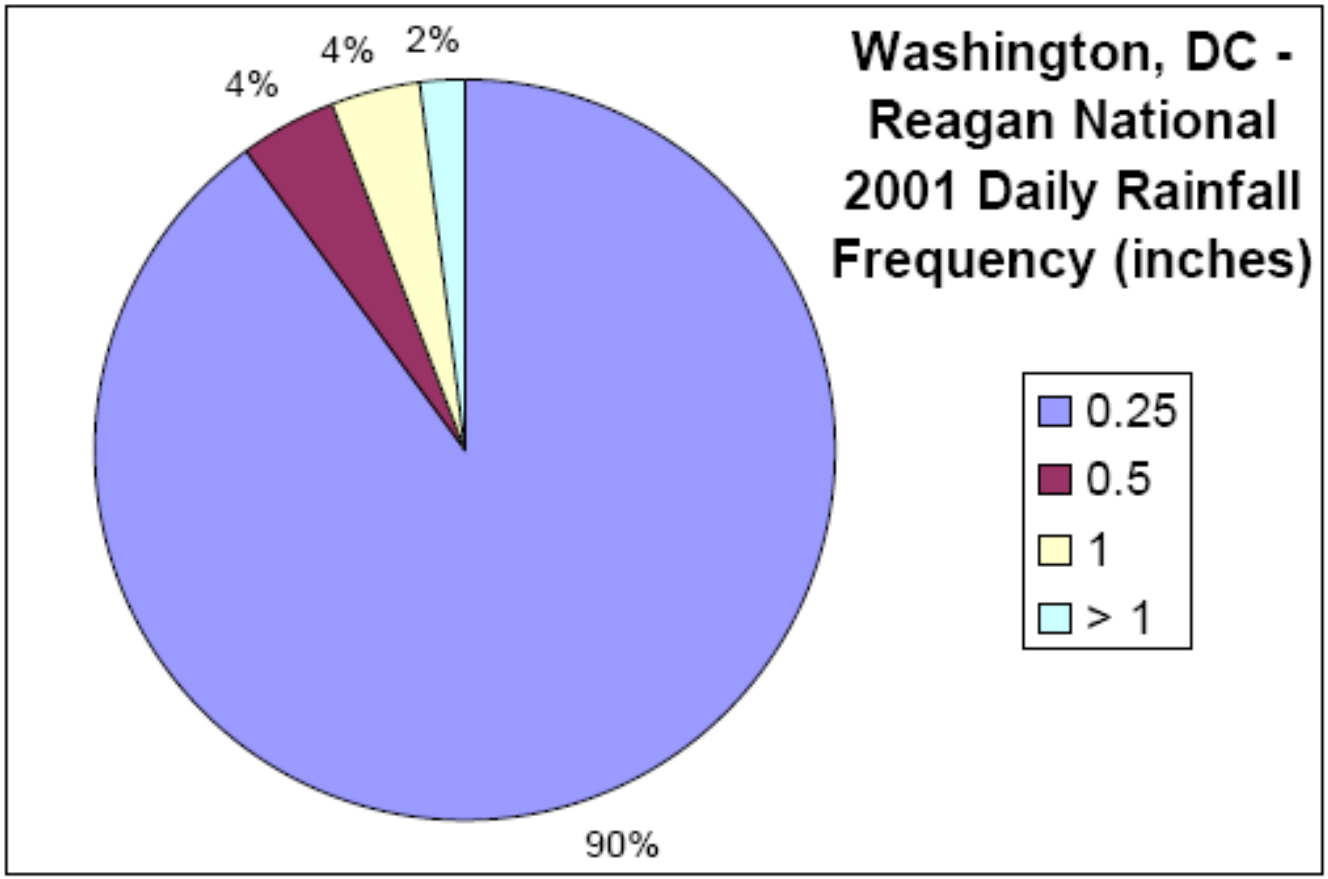
# How much water does this treat?

- 90% of rainfall events are less than 1.25"
- New Jersey has approx. 44" of rain per year
- The rain garden will treat and recharge:

  0.9 x 44" = 40"/year = 3.3 ft/year
- The rain garden receives runoff from 1,000 sq.ft.
- Total volume treated and recharged by the rain garden is 1,000 sq. ft. x 3.3 ft. = 3,300 cubic feet,

  which is 25,000 gallons per year
- **Build 40 of these and we have treated and recharged 1,000,000 gallons of water per year!**

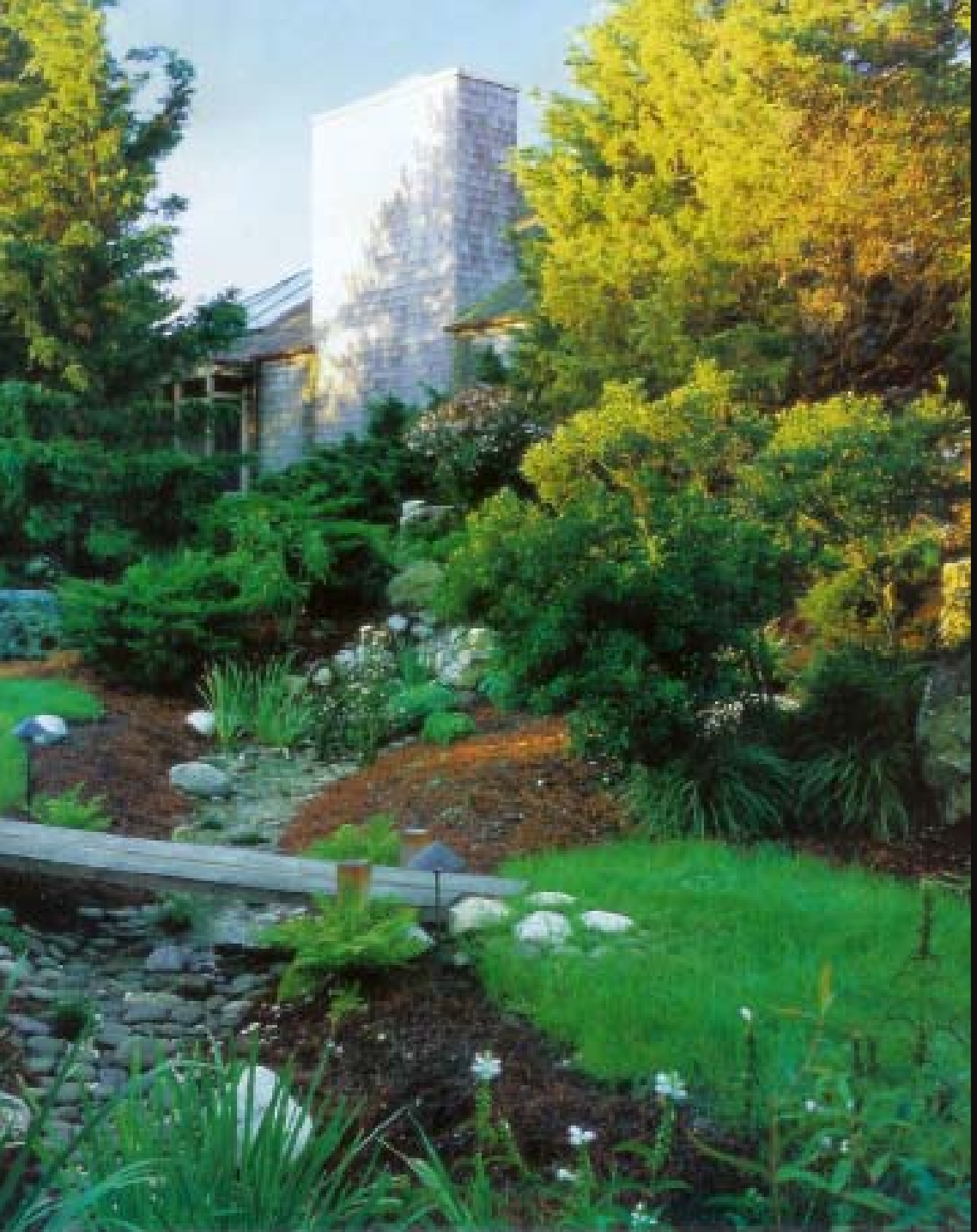
## Figure 4-3. Frequency of Small Storms

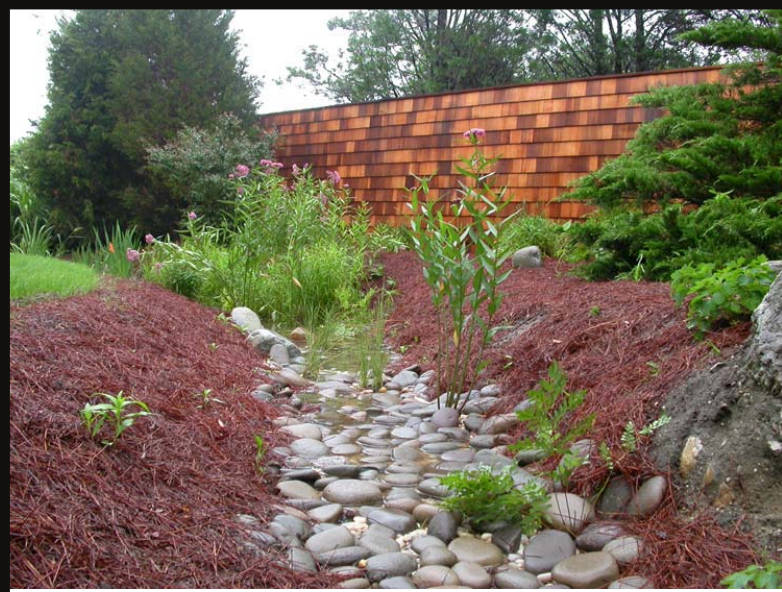



Source: NOAA.

# NC State Findings

- 90 percent removal of bacteria
- 56-86 percent removal of metals (Cu and Zn)
- 65-68 percent removal of phosphorus (one was 22 percent – removal depends on basin material)
- 40-65 percent removal of nitrogen
- Water temperature reduced 5-10 degrees

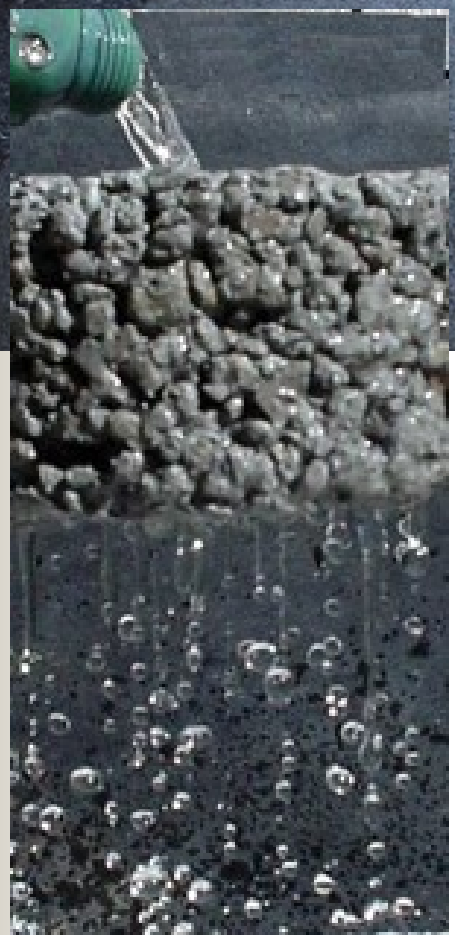




# More is Better

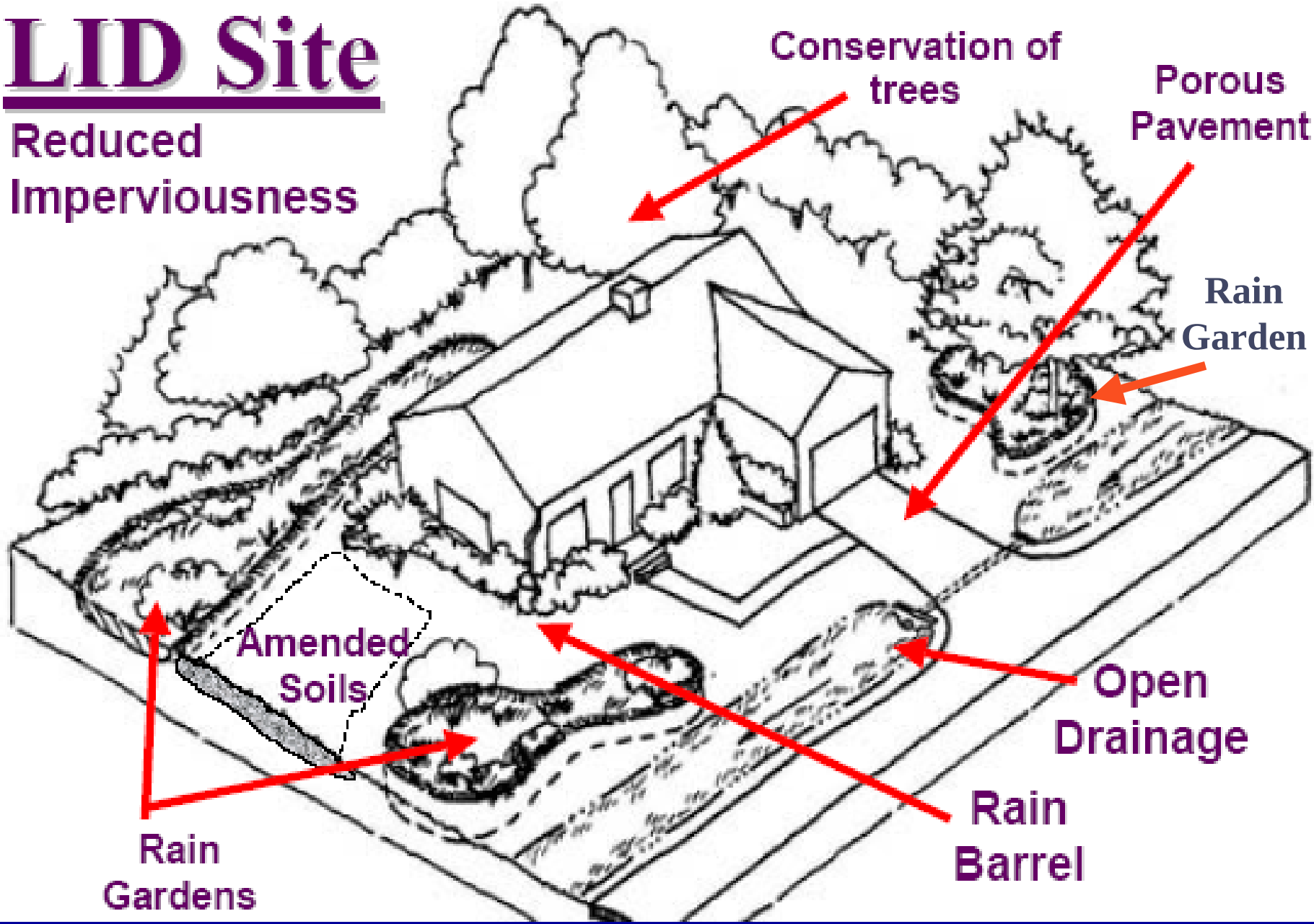
Reinforced gravel pervious driveways

# Porous Concrete



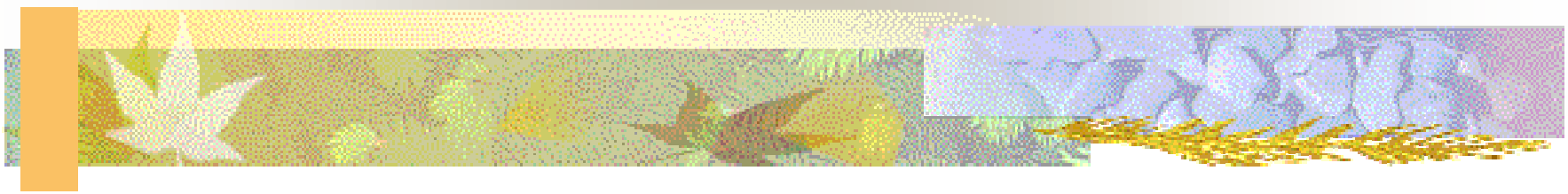
# LID Site

Reduced Imperviousness




**Create a Hydrologically Functional Lot**

# Public Works Scale
# Bioretention



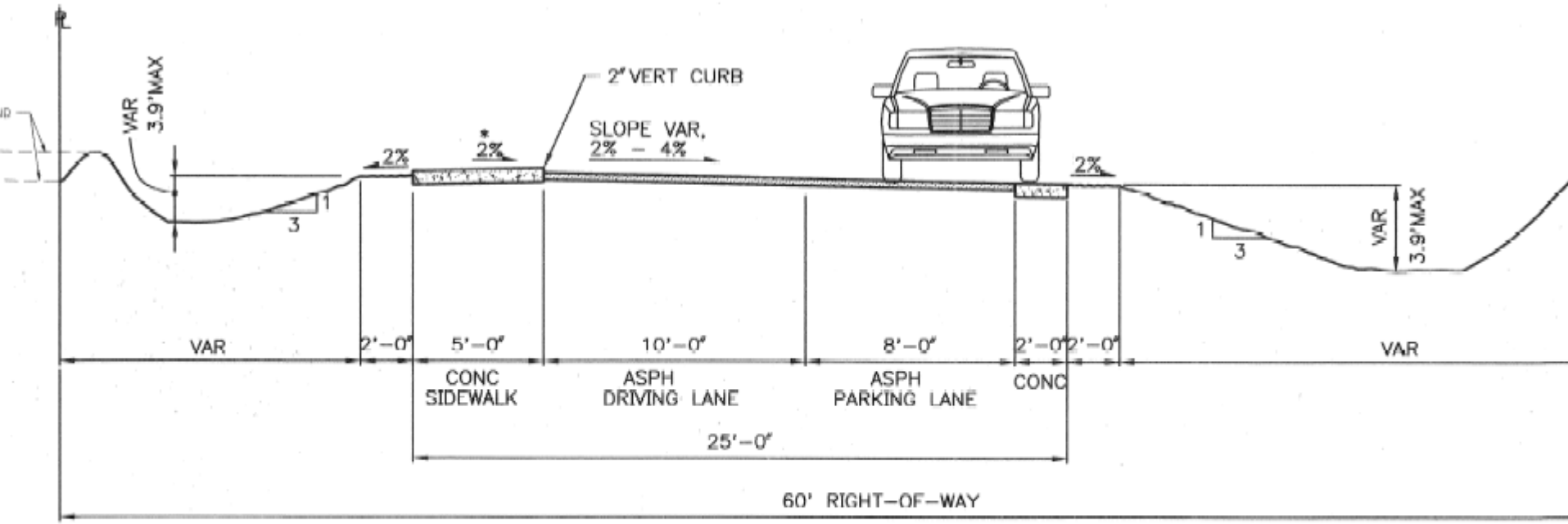
Forget about gravity.

Water flows toward money.


Before Natural Drainage

# Seattle's Street Edge Alternatives Program

After Completion - January 2001




* 2% TOWARD S
2% TOWARD S

# TYPICAL SEA STREET R/W X-SECTION

## (1ST AVE NW, 2ND AVE NW, PALATINE AVE N & PHINNEY AVE N)

NTS

**Two years of monitoring:**

Infiltrates 98% of a 2-year, 24-hour storm event (1.68-inches) peak runoff rate and volume.


Puget Sound
Pipers Creek
Carkeek Park
Broadview
Green Grid
NW 125th St
Greenwood Ave NW
Dayton AVE N
Aurora Ave N
NW 105th St
NW 100th St
Holman Rd NW
8th Ave NW
3rd Ave NW



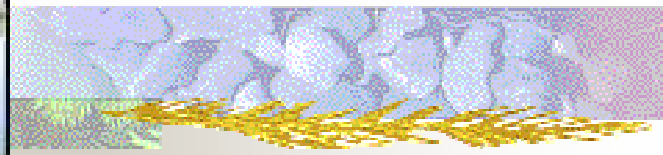

SEATTLE PUBLIC UTILITIES
DRAINAGE CONCEPT STUDY
LEGEND
ENGINEERED SOIL RETENTION SWALE - 1" SURFACE STORAGE
ENGINEERED SOIL RETENTION POND - 1" SURFACE STORAGE
ENGINEERED SOIL RETENTION - 1" - 2" SURFACE STORAGE
SUBSURFACE GRAVEL STORAGE

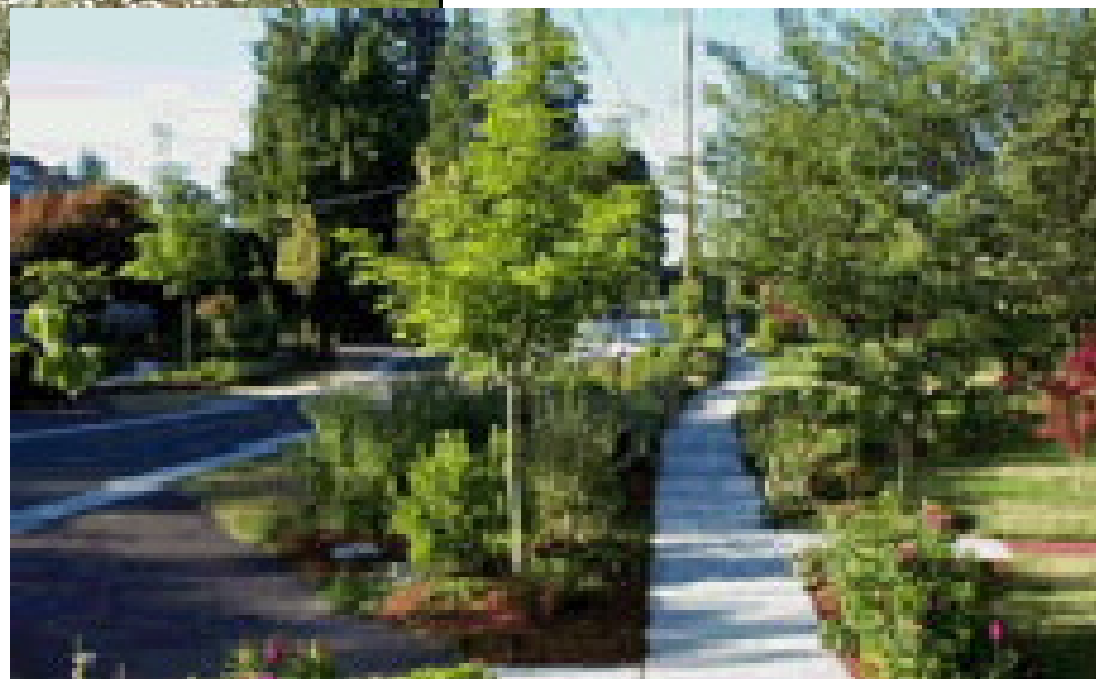
**Before**

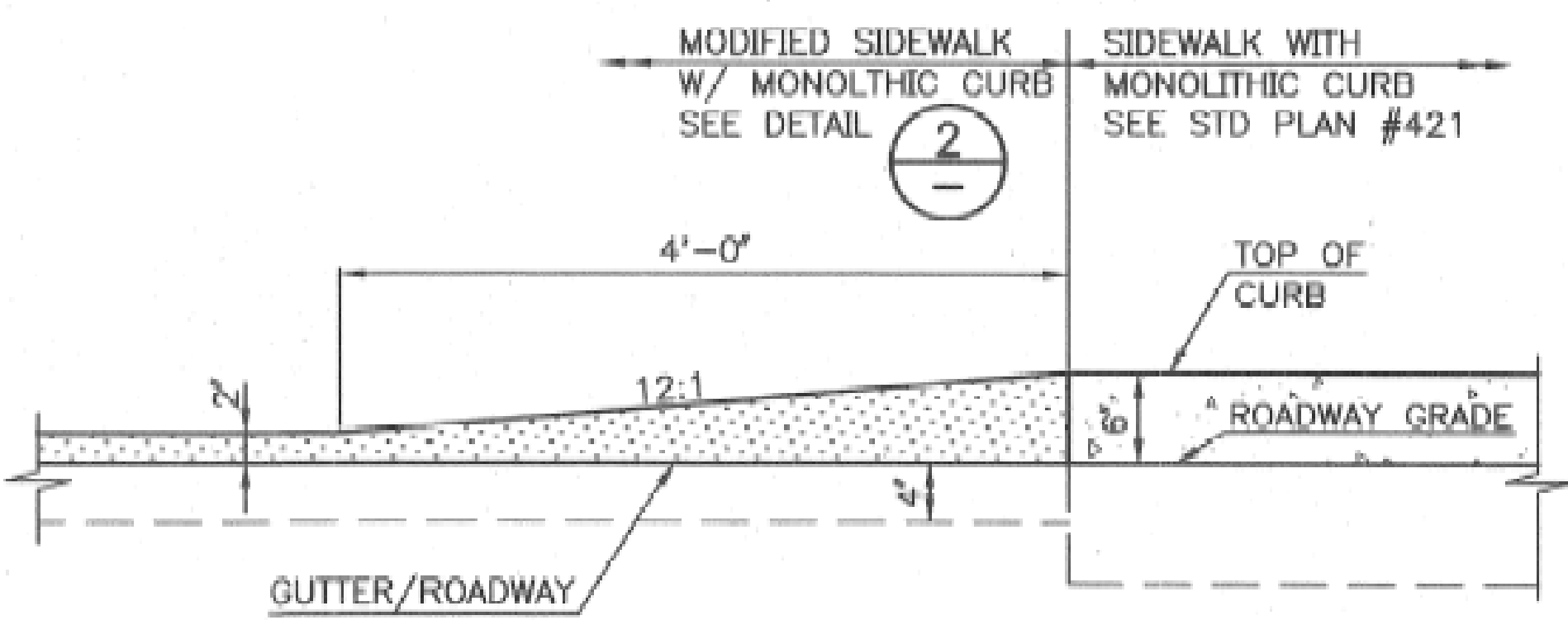
**As Planned**


Early


Mature



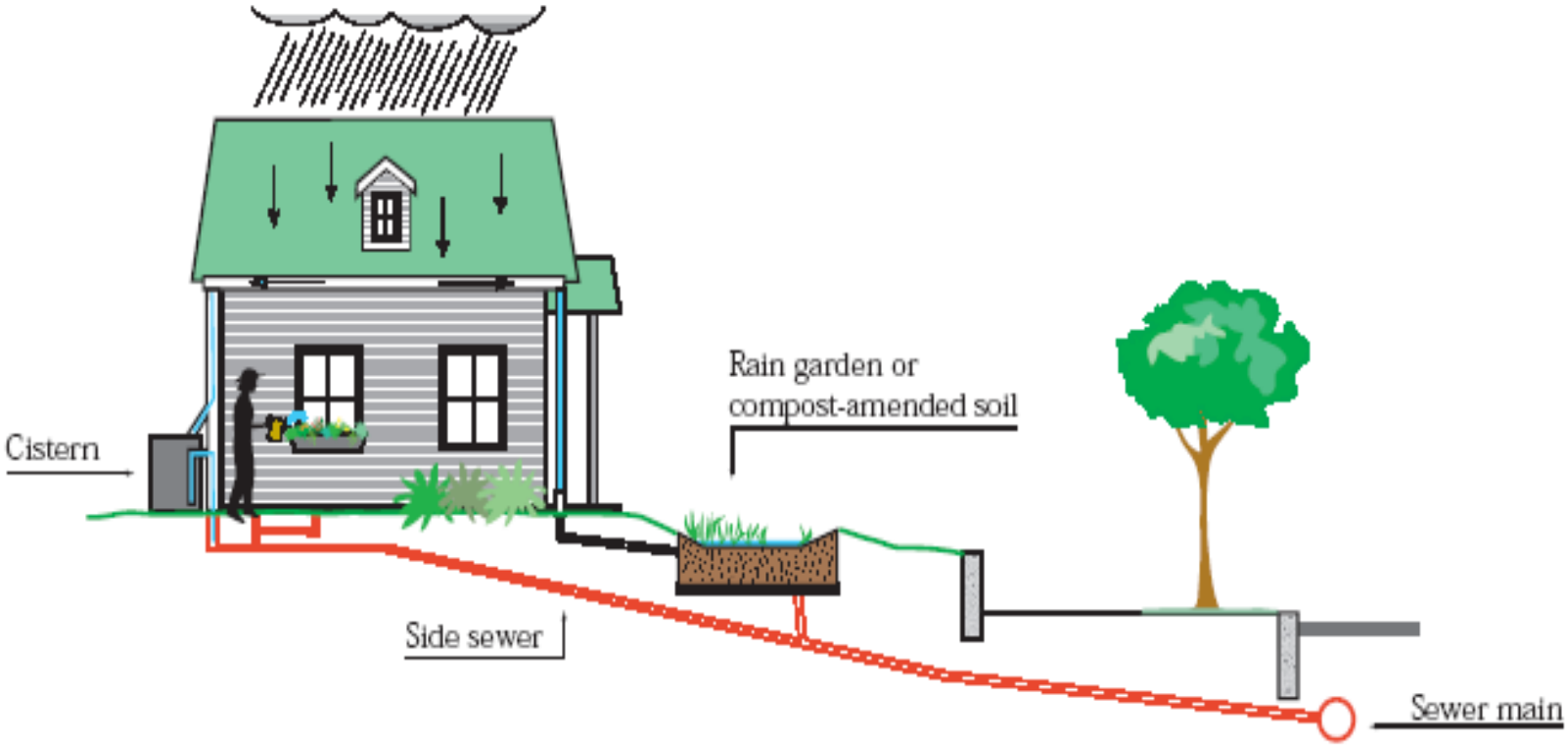





# DETAIL 1/— CURB HEIGHT TRANSITION

SCALE: 1" = 1'-0"

| Street Type | *Local street*<br>**SEA Street** | *Local street*<br>Traditional |
|---|---|---|
| Community Benefits | ▪ one sidewalk per block<br>▪ new street paving<br>▪ traffic calming<br>▪ high neighborhood aesthetic | ▪ two sidewalks per block<br>▪ new street paving<br>▪ no traffic calming<br>▪ no neighborhood aesthetic |
| Ecological Benefits | ▪ high protection for aquatic biota<br>▪ mimics natural process<br>▪ bio-remediate pollutants | ▪ high protection from flooding<br>▪ some water quality |
| % impervious area | 35% | 35% |
| Cost per block (330 linear feet) | $325,000 | $425,000 |

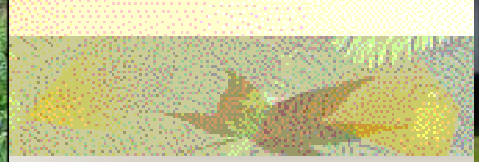



*Cisterns catch roof runoff during storms, then slowly release it, to prevent flooding and sewer overflows.*

Swale cell construction
on NW 107th St.

Asphalt-lined ditch,
pre-construction


MAY 16 2001

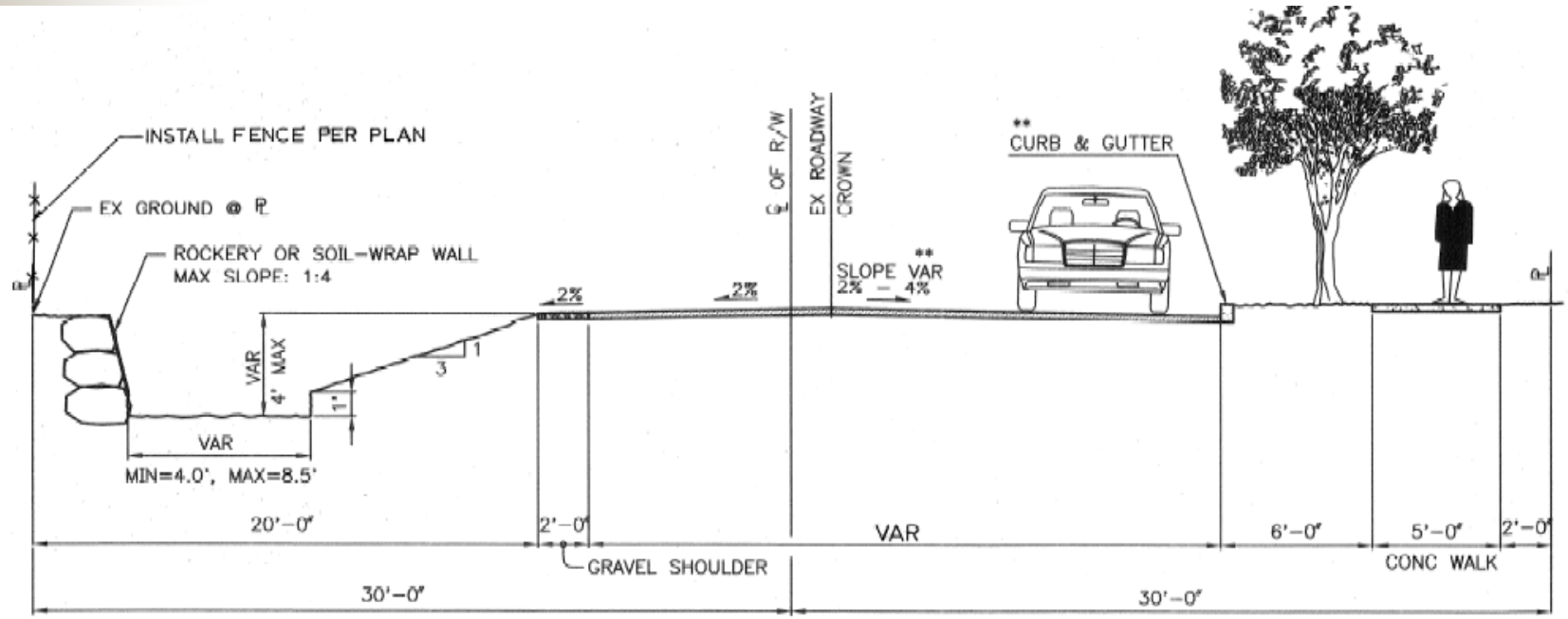



7123 SE Powell


6/22/2000


6/24/2000


You can create ditches that not only convey water but that also absorb water.




## TYPICAL CASCADE R/W X-SECTION

(NW 107TH ST & N 107TH ST)

NTS

** CURB AND GUTTER AND ASPH
OCCUR ON LIMITED AREA. SE

*Seattle Cascades:*

**Grade Control**

***AND***

**Infiltration**

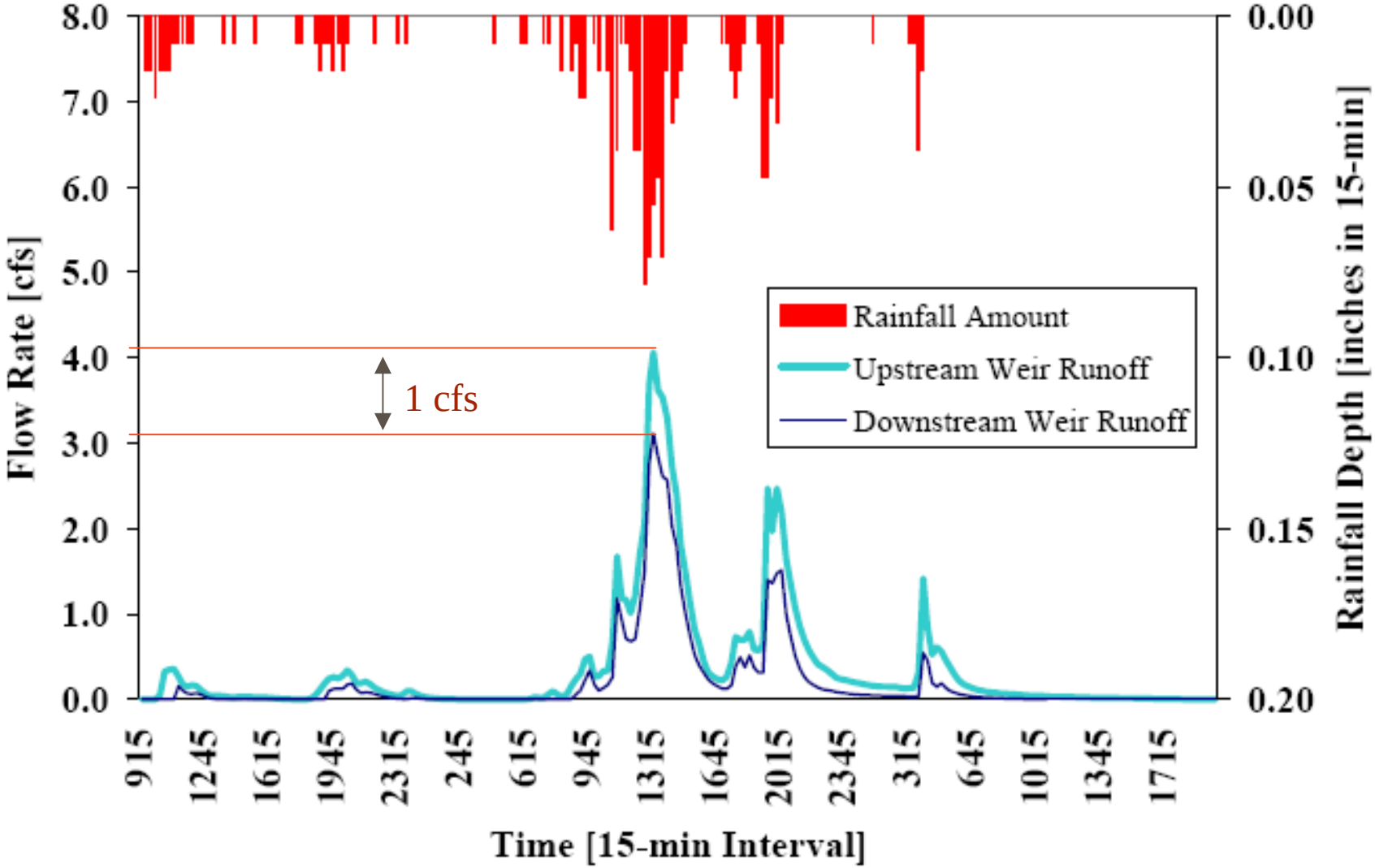
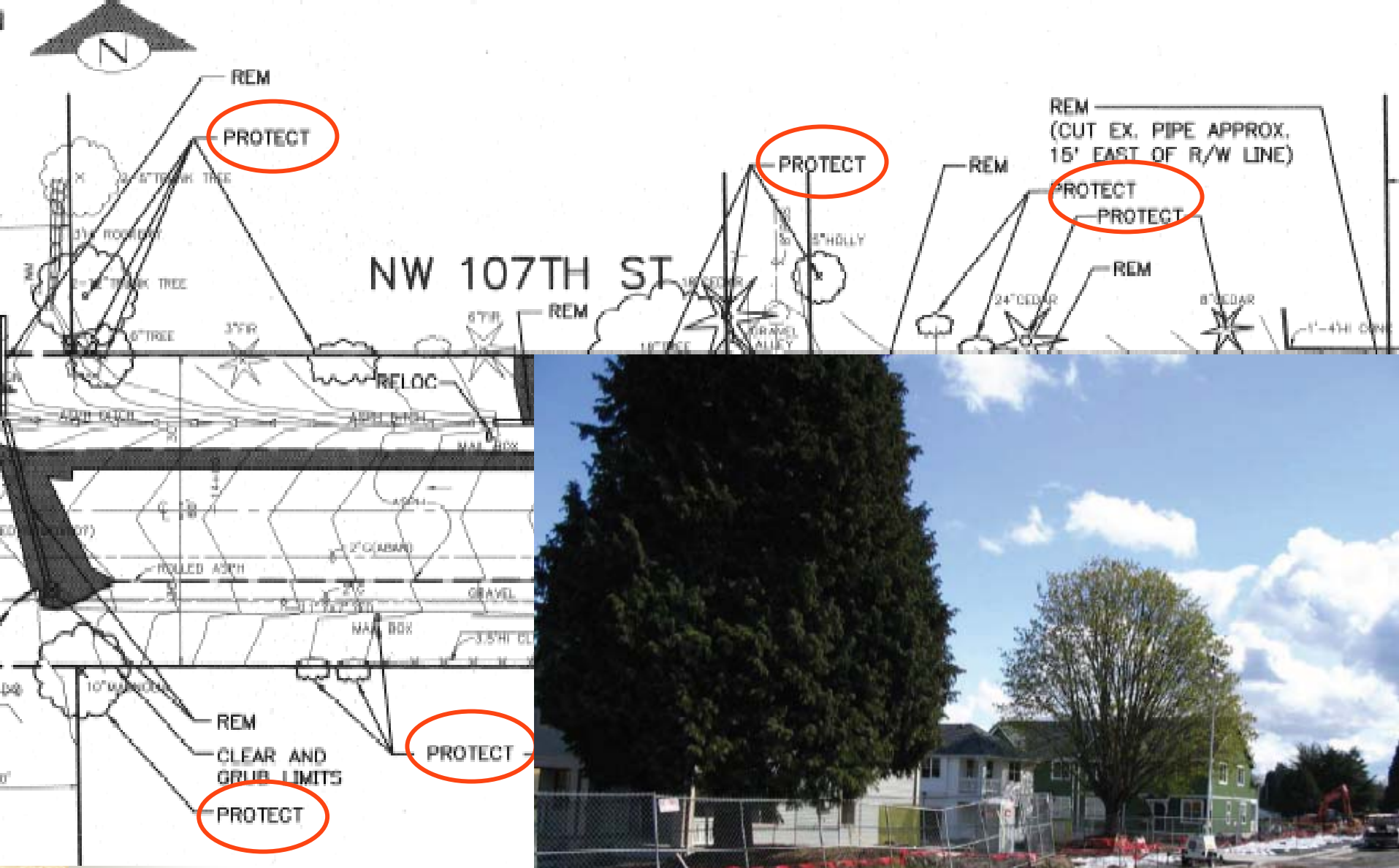
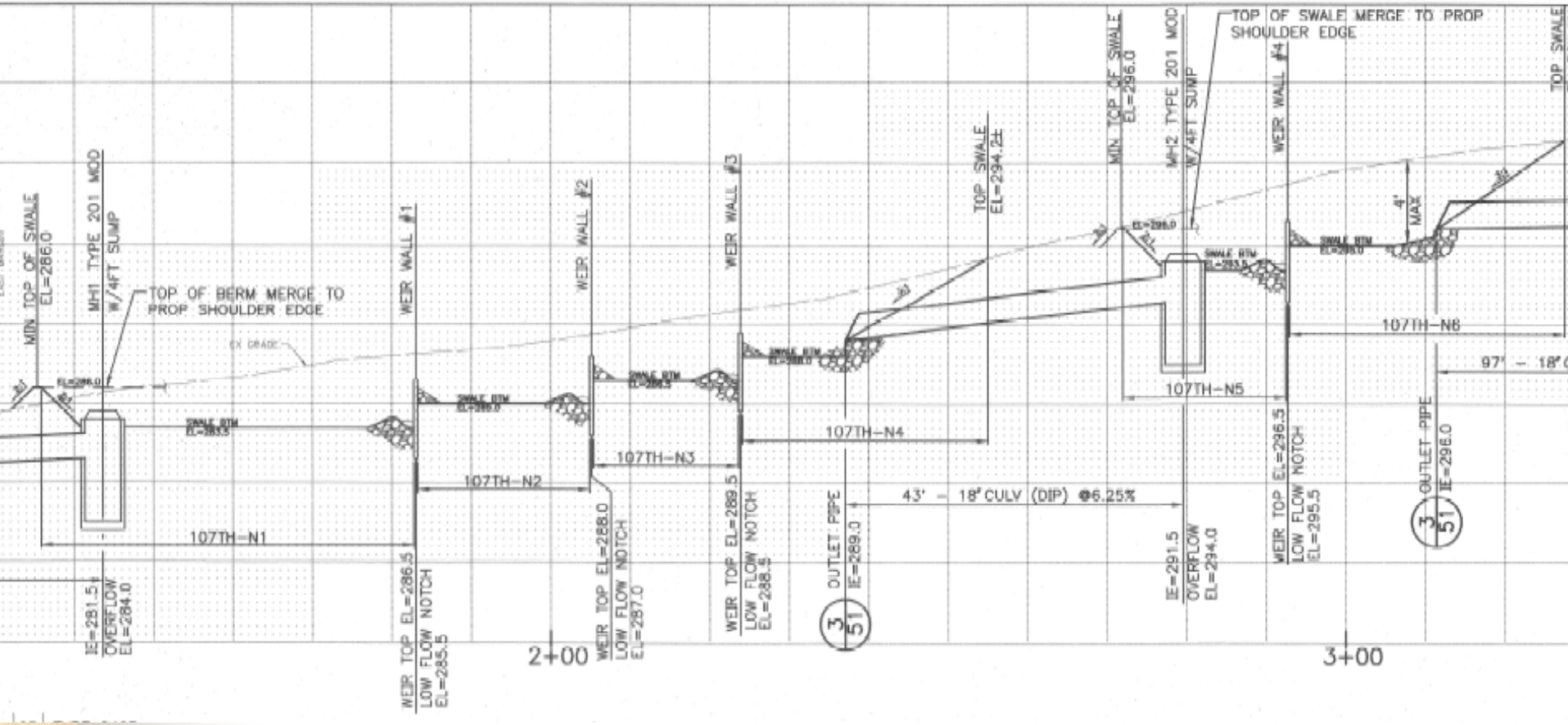



**Figure 3-1. Viewlands Rainfall Hyetograph and Runoff Hydrograph, December 12 (9:15 AM) - December 14 (7:30 PM), 2001**





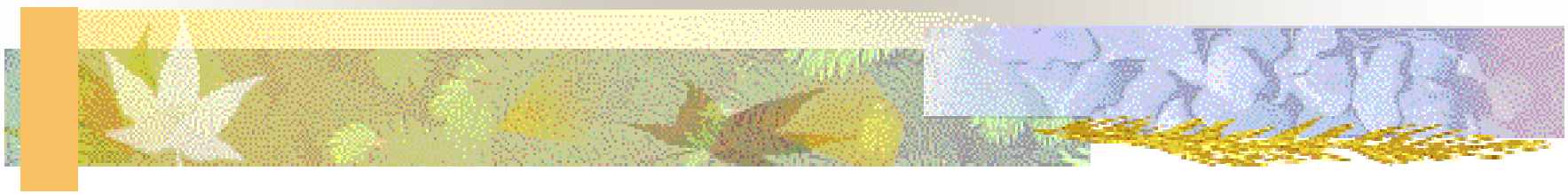

Trees 229 and 289




25 foot change in elevation

| Street Type | *Collector street* Cascade | *Collector street* Traditional |
|---|---|---|
| Community Benefits | ▪ no street improvement<br>▪ moderate neighborhood aesthetic | ▪ no street improvement<br>▪ no neighborhood aesthetic |
| Ecological Benefits | ▪ high water quality protection<br>▪ some flood protection | ▪ high protection from flooding<br>▪ some water quality |
| % impervious area | 35% | 35% |
| Cost per block (330 linear feet) | $285,000 | $520,400 |

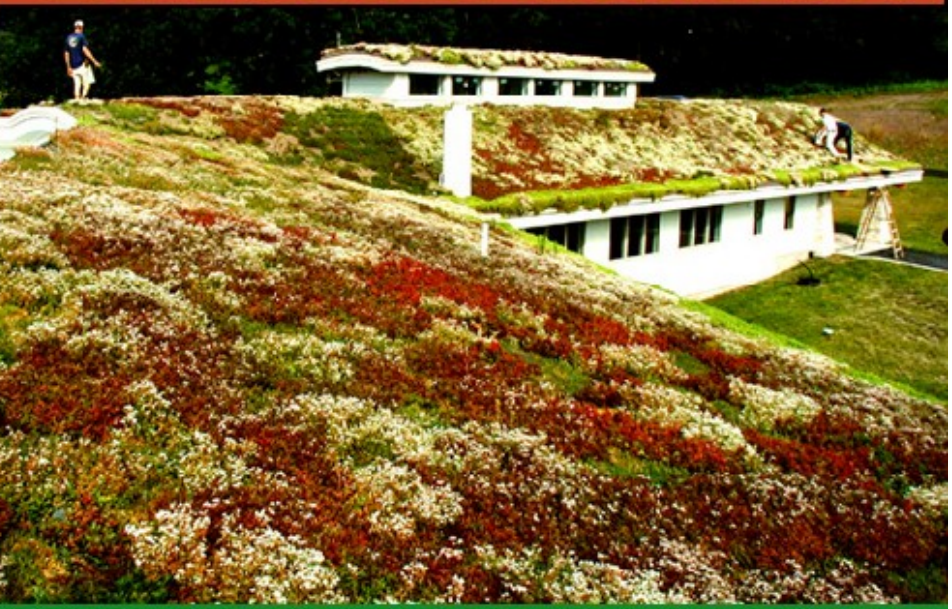
# Commercial Scale Bioretention



*Reality Environmentalism*

# S. Edgar David & Associates

## LANDSCAPE ARCHITECTS



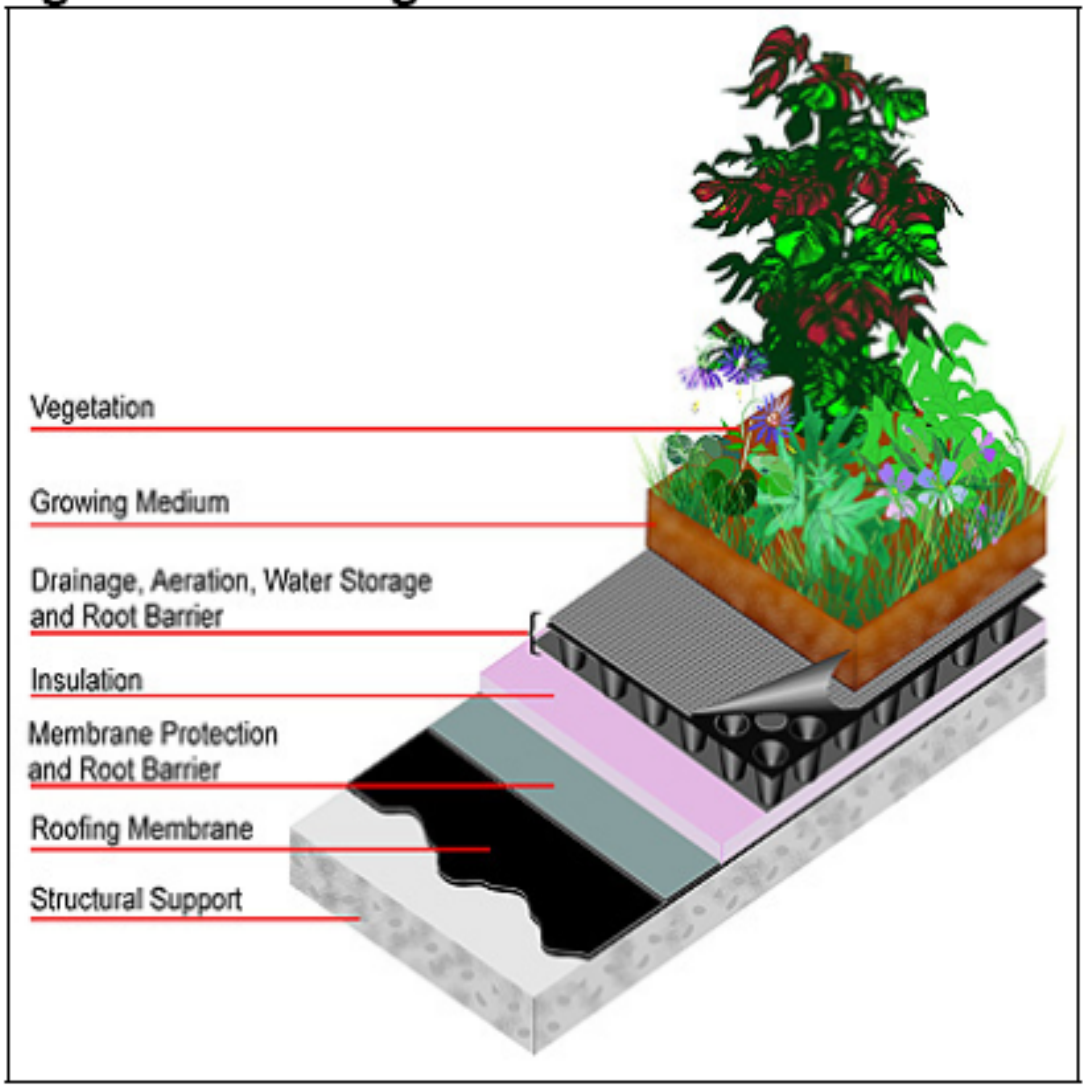
*Green Roofs transform our urban environment together with roof top garden then create more useable outdoor space.*

# S. Edgar David & Associates

## LANDSCAPE ARCHITECTS

*Green Roofs*
*In collaboration with Charlie Miller of Roofscapes Inc. and David Brothers Landscape Services. S. Edgar David Associates provides design for Green Roofs and Rooftops Gardens*

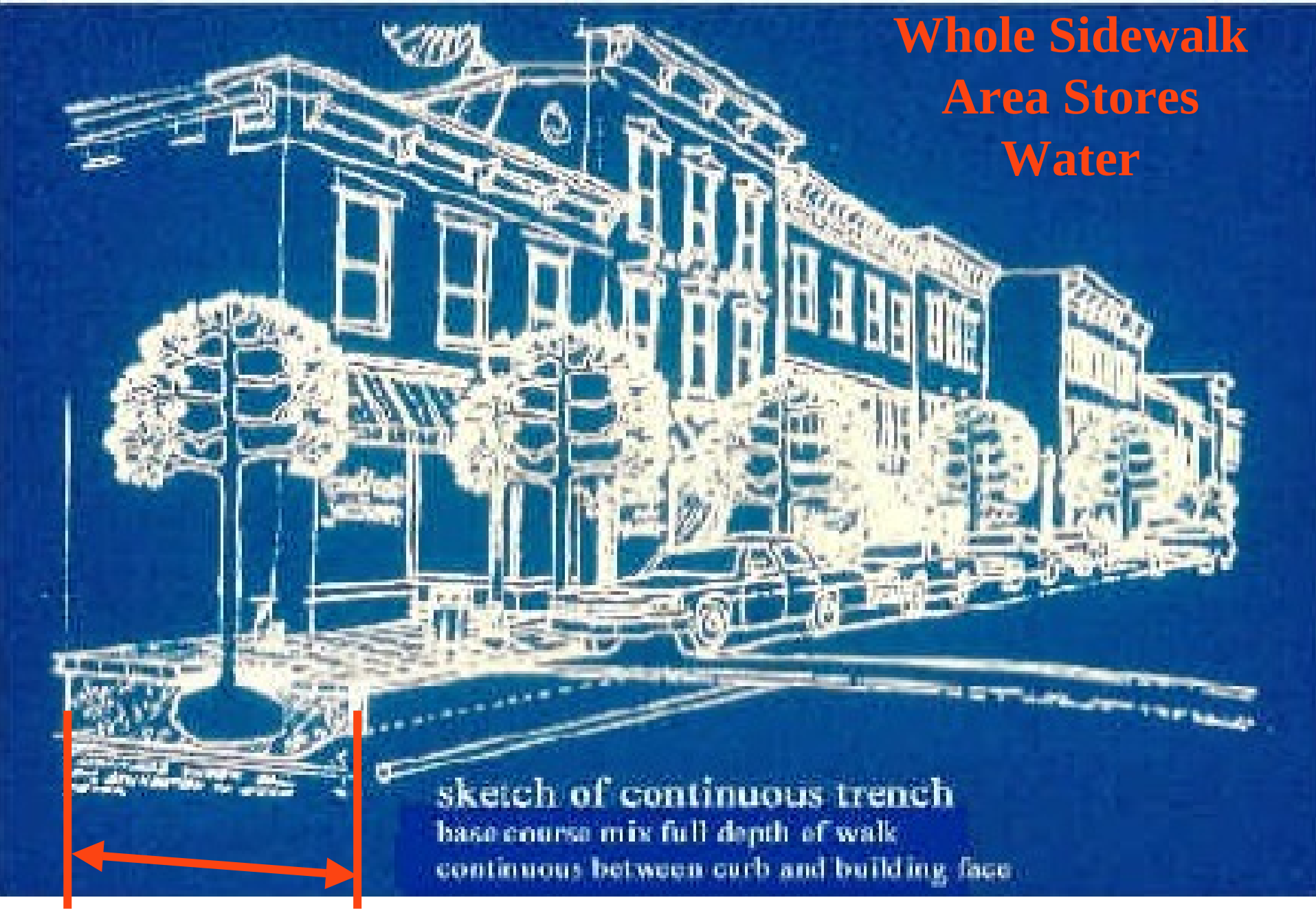
## Figure 8-12. Vegetated Roof Cross-Section




Source: American Wick Drain Corp.

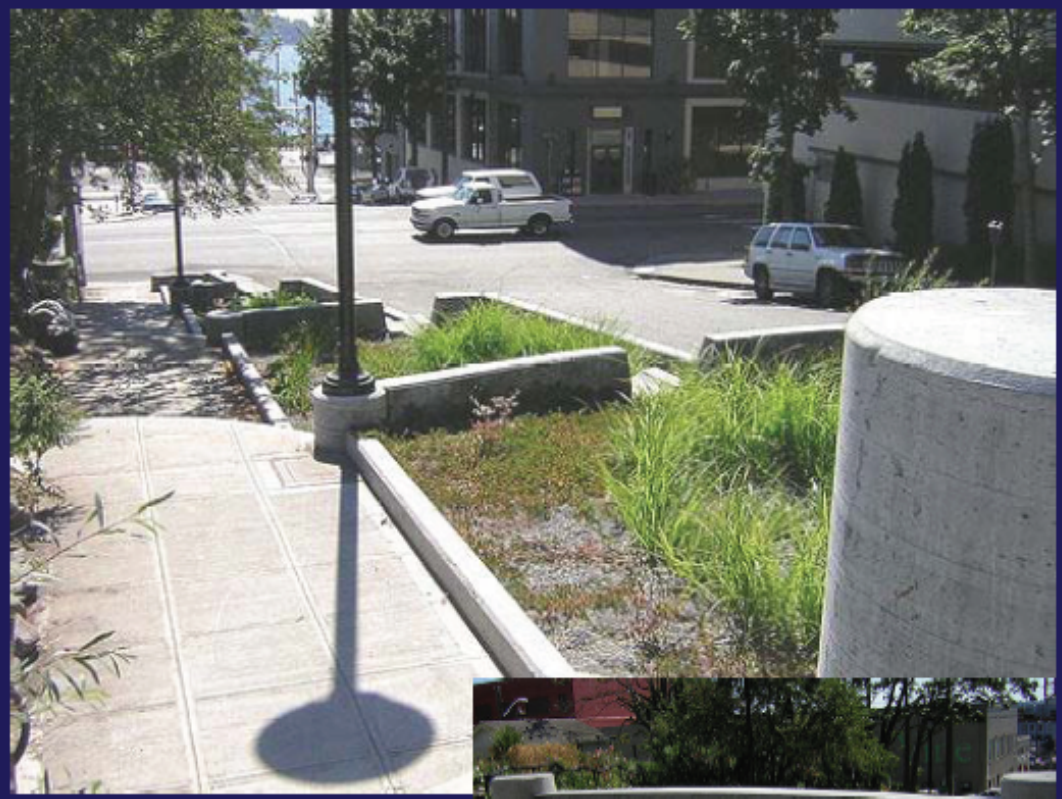
Buckman Terrace courtyard with infiltration garden

Buckman Terrace Apartments (303 NE 16th Ave.)

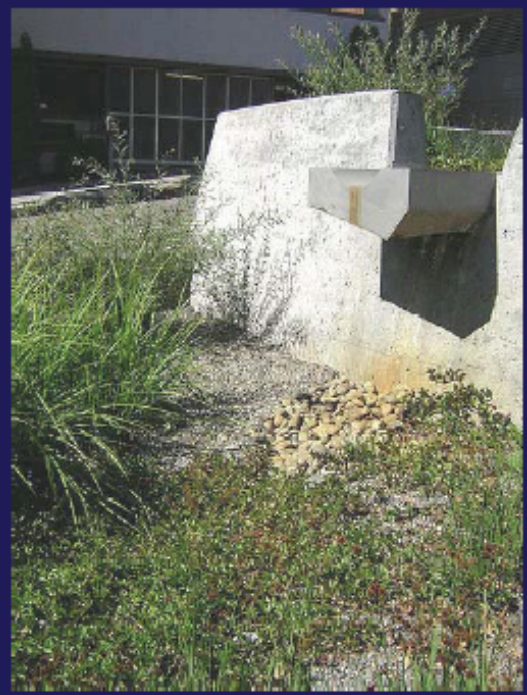

Whole Sidewalk
Area Stores
Water
sketch of continuous trench
base course mix full depth of walk
continuous between curb and building face

# Seattle: Growing Vine Street

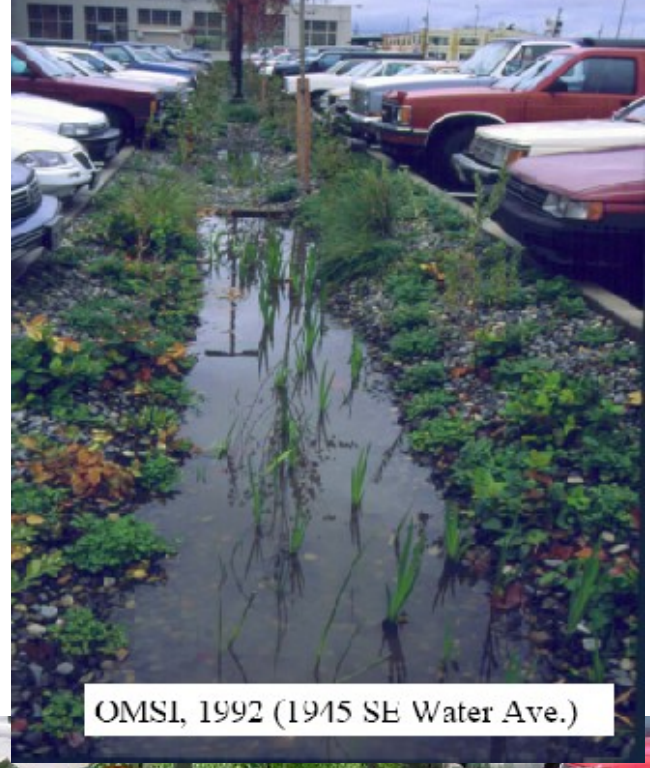
- Urban Drainage
- Cascade of Pools
- Cleans Stormwater Runoff
- Educate
- Art integration
- Pea Patch



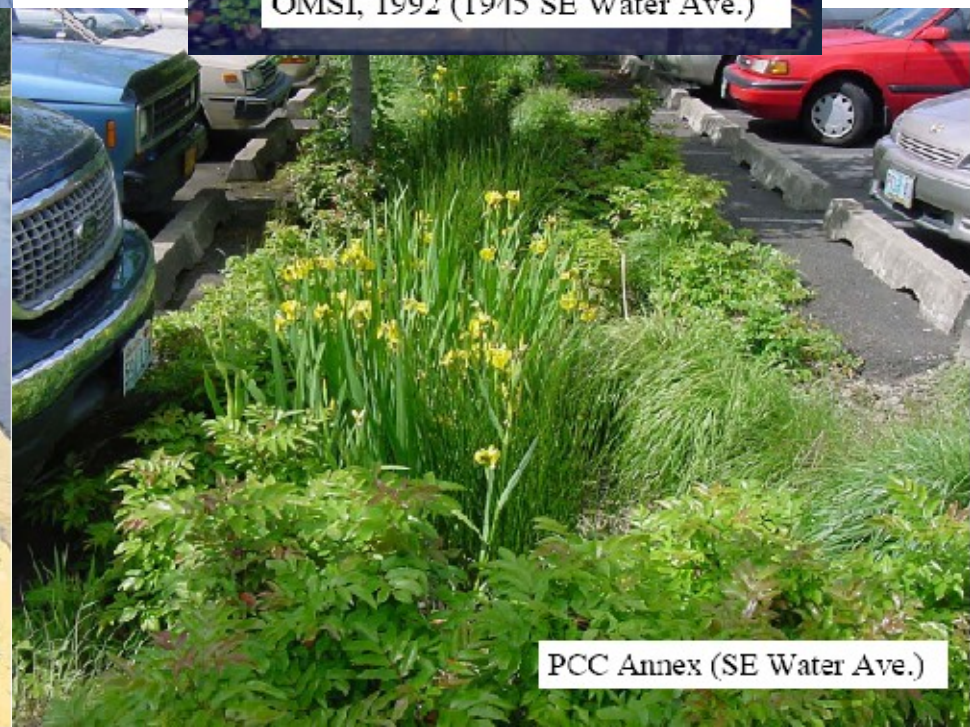

The "Cistern Steps"



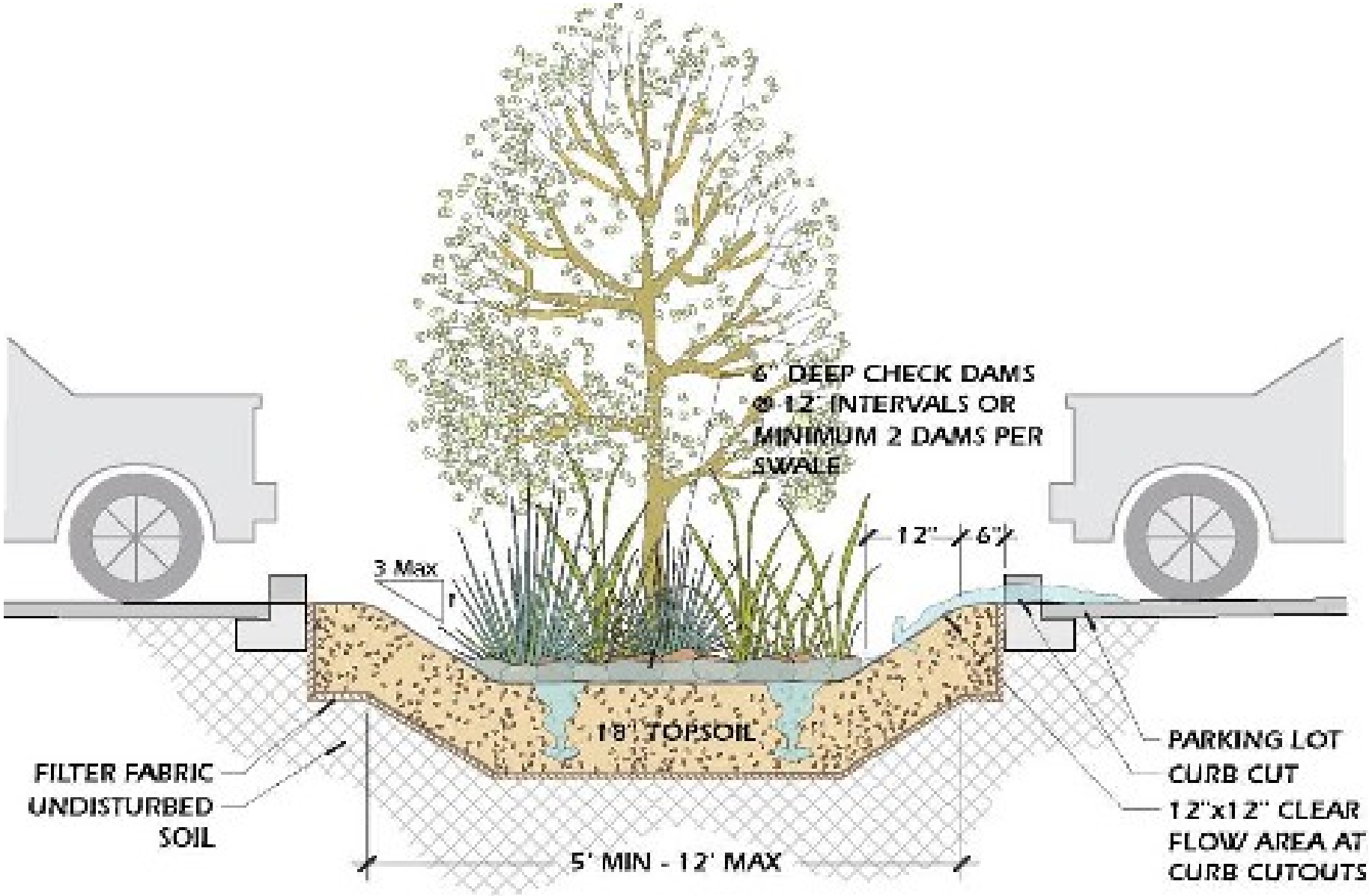
OMSI, 2001 (1945 SE Water Ave.)



OMSI, 1992 (1945 SE Water Ave.)



PCC Annex (SE Water Ave.)

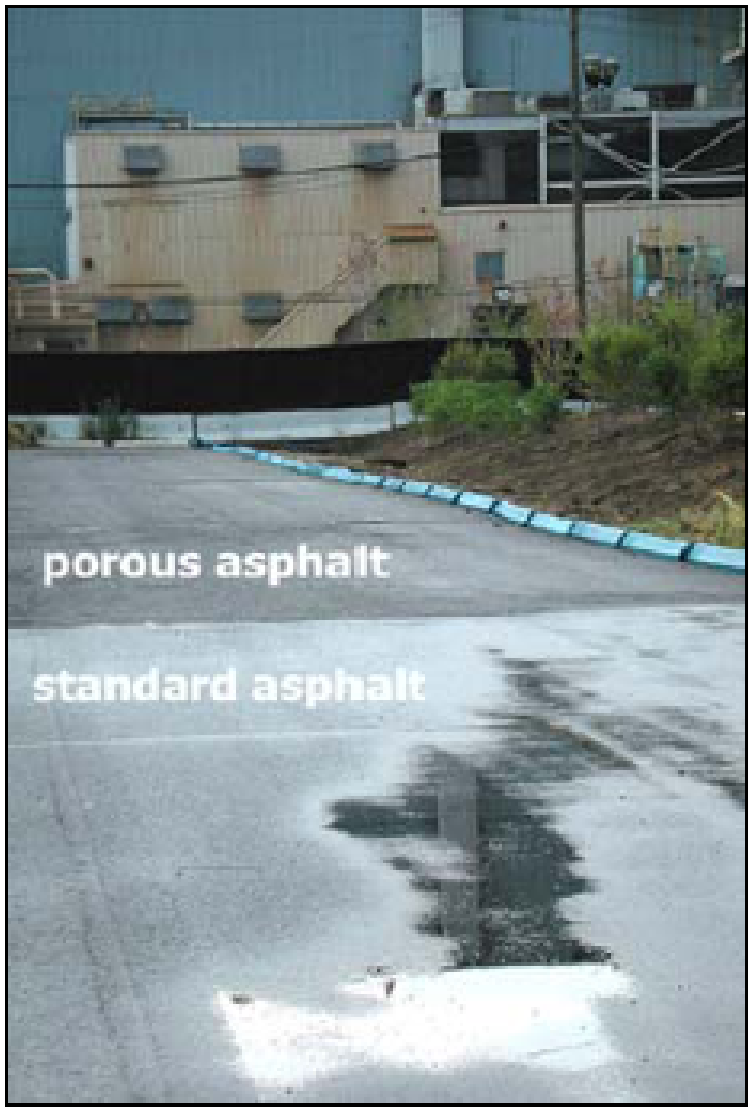


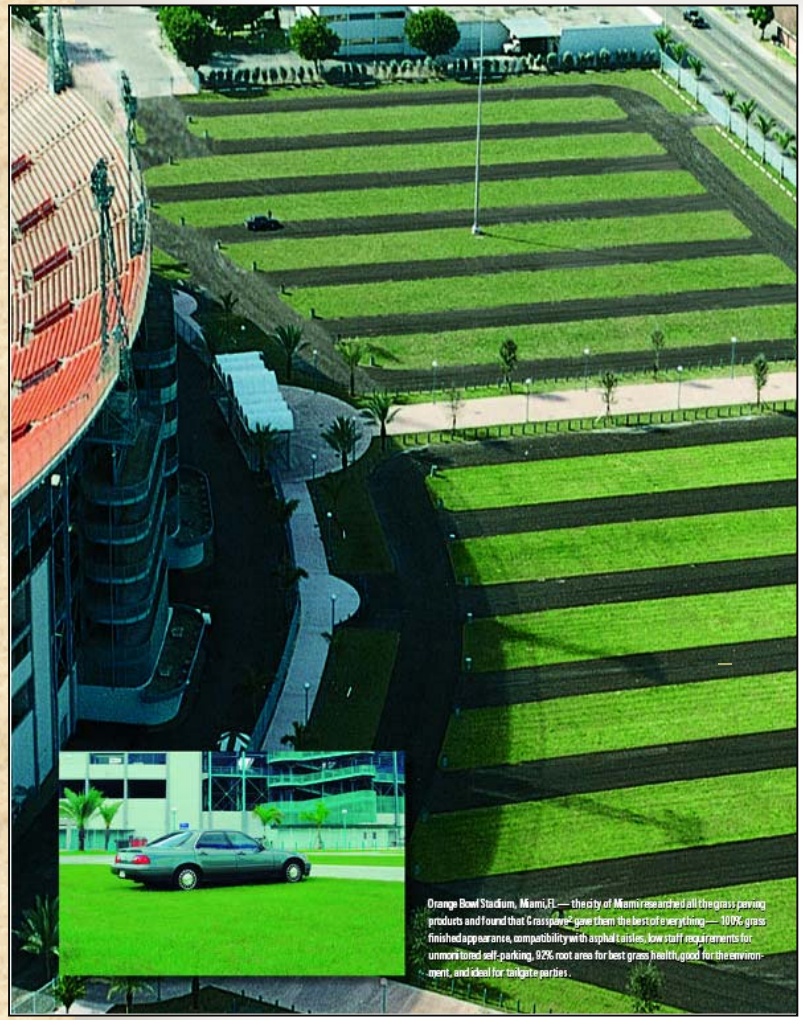

SIMPLIFIED APPROACH DESIGN CRITERIA

# Vegetated Swale


Runoff
Runoff
Runoff
Sheet Flow
Sheet Flow
Overflow Structure
May Also Be Used
as Outlet Structure
for Stormwater Quantity
Control.
Underdrain System
Cleanout
Energy
Dissipator
Maximum Water Quality Storm
Depth – 12 Inches
Filter
Fabric
Planting Soil Bed
Gravel
Underdrain
Sand Layer
Perforated Pipes

# Figure 8-15. Drainage in Both Types of Pavement




The Miami Orange Bowl – “tailgate party” parking

The Pentagon now uses pervious grass paving for helicopters.

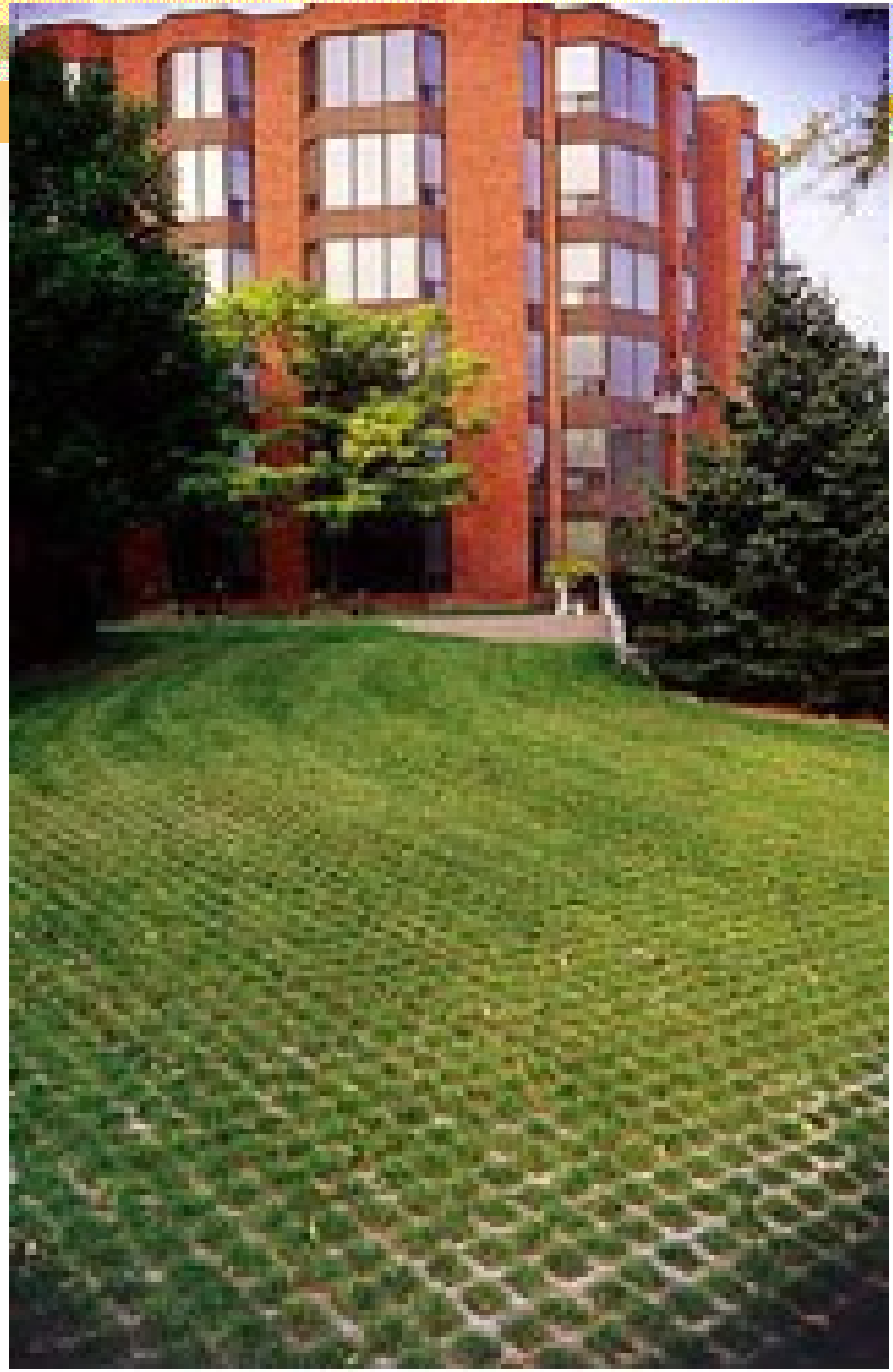


Figure 10-8. Map of Proposed Conditions (LID Design)

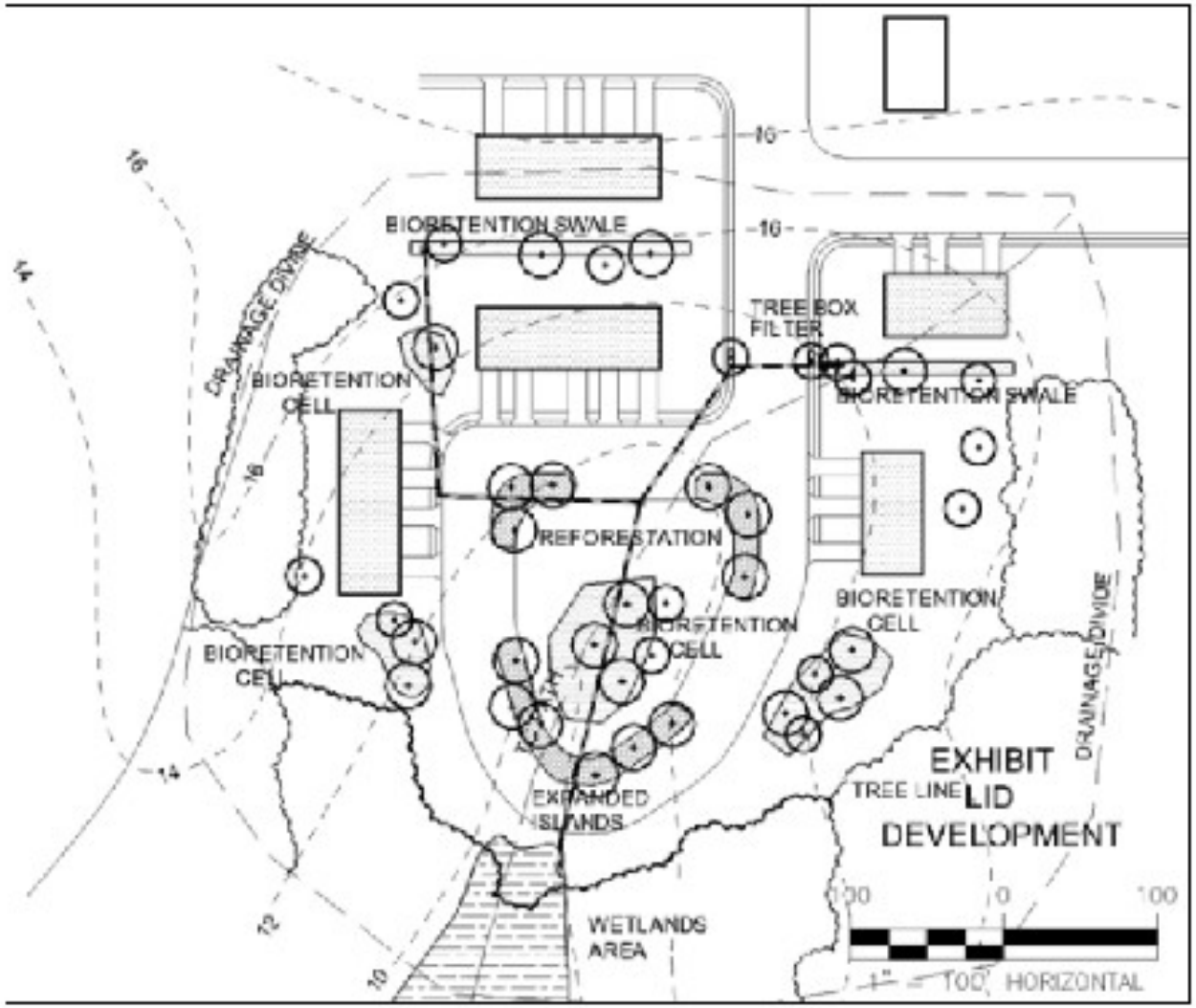



Table 10-5. Composite CN Calculation for Proposed Condition Using LID

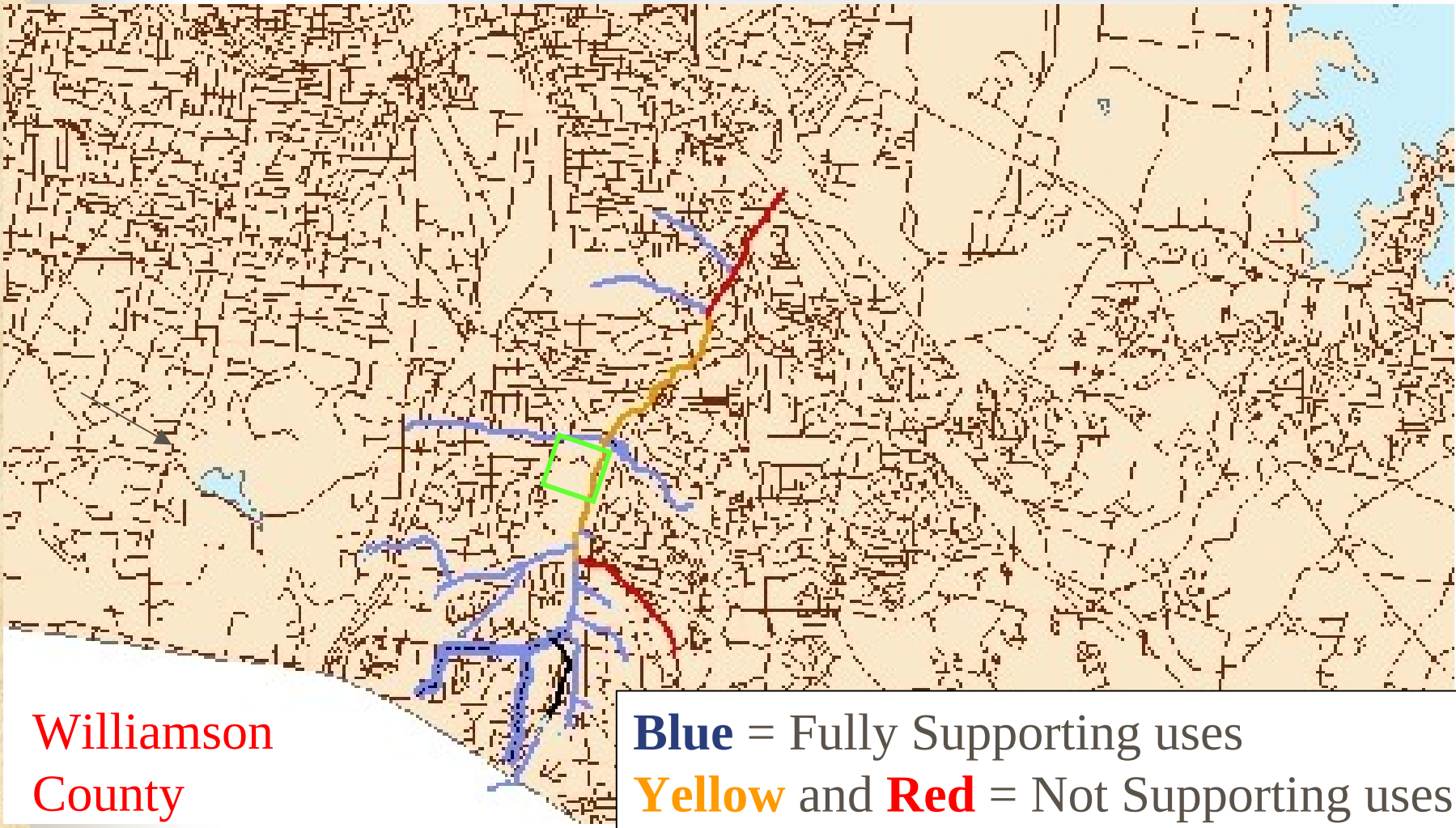
## Table 6-1. Functions of LID Features

| Feature | Effect or Function | | | | |
|---|---|---|---|---|---|
| | Slower Runoff | Infiltration | Retention | Detention | Water Quality Control |
| Soil Amendments | | X | | | |
| Bioretention | | X | X | X | X |
| Dry Wells | | X | X | | X |
| Filter Strips | X | | | | X |
| Vegetated Buffers | X | | | | X |
| Grassed Swales | X | | | | X |
| Infiltration Trenches | | X | | | X |
| Inlet Devices | | | | | X |
| Rain Barrels | | | X | | |
| Cisterns | | | X | | |
| Tree Box Filters | | | | | X |
| Vegetated Roofs | X | | | X | X |
| Permeable Pavers | | X | | | X |

# *Our Vision for Ellington:*

## *Use Natural Solutions*

# Basic GIS map showing Sevenmile Ck watershed, roads, major area lakes



Williamson County

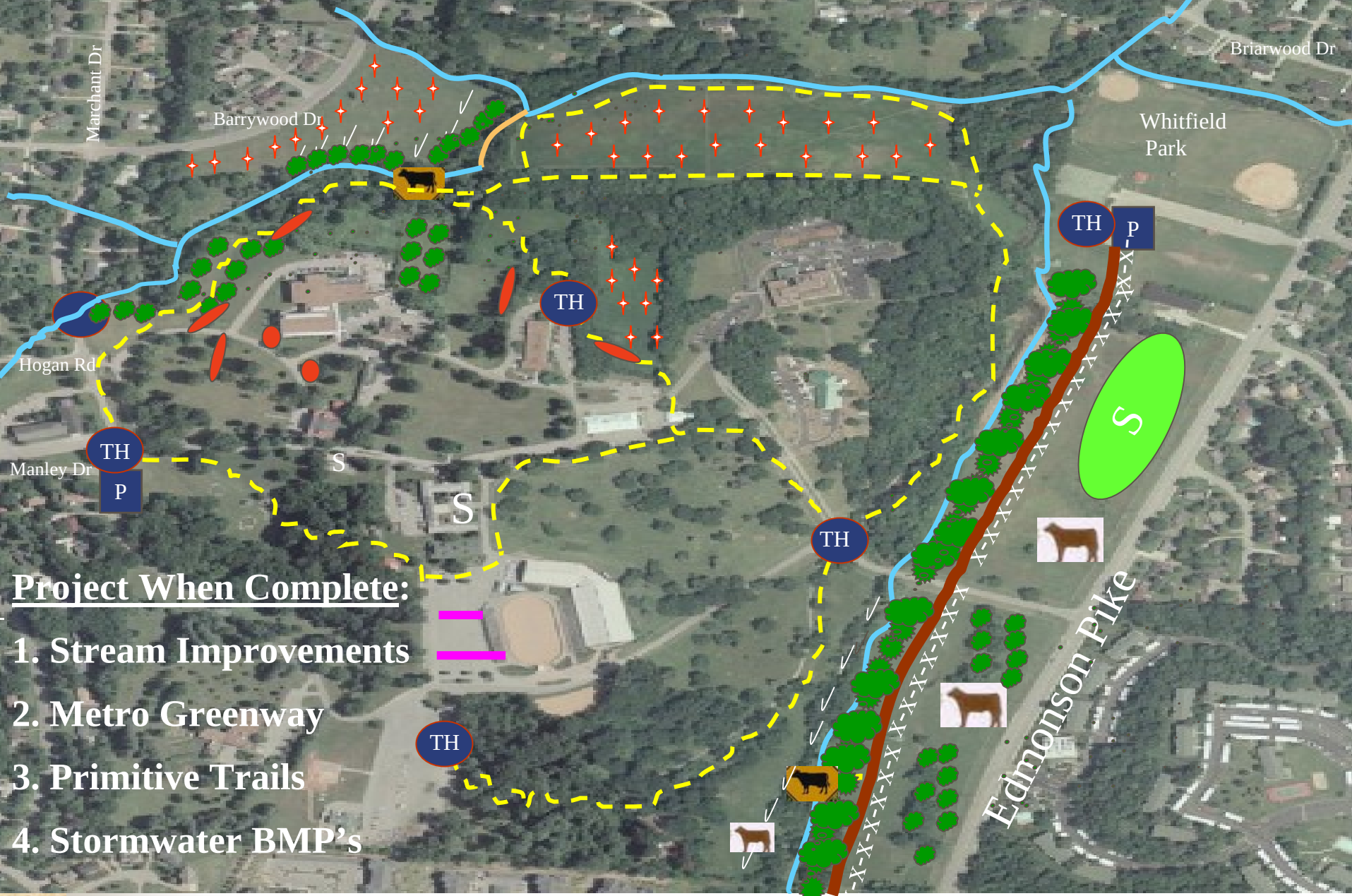
= Ellington

**Blue** = Fully Supporting uses

**Yellow** and **Red** = Not Supporting uses

**Black** = Not Assessed

Source: TDEC's On-line Water Assessment


Marchant Dr
Barrywood Dr
Briarwood Dr
Whitfield Park
Hogan Rd
Manley Dr
TH
P
S
Edmonson Pike
Project When Complete:
1. Stream Improvements
2. Metro Greenway
3. Primitive Trails
4. Stormwater BMP's
= Hiking Trail
Pervious Paving
Paved Trail
= Warm Season Grasses
= Tree Buffer
= Trail Head
= Stormwater BMP's


Rain Garden

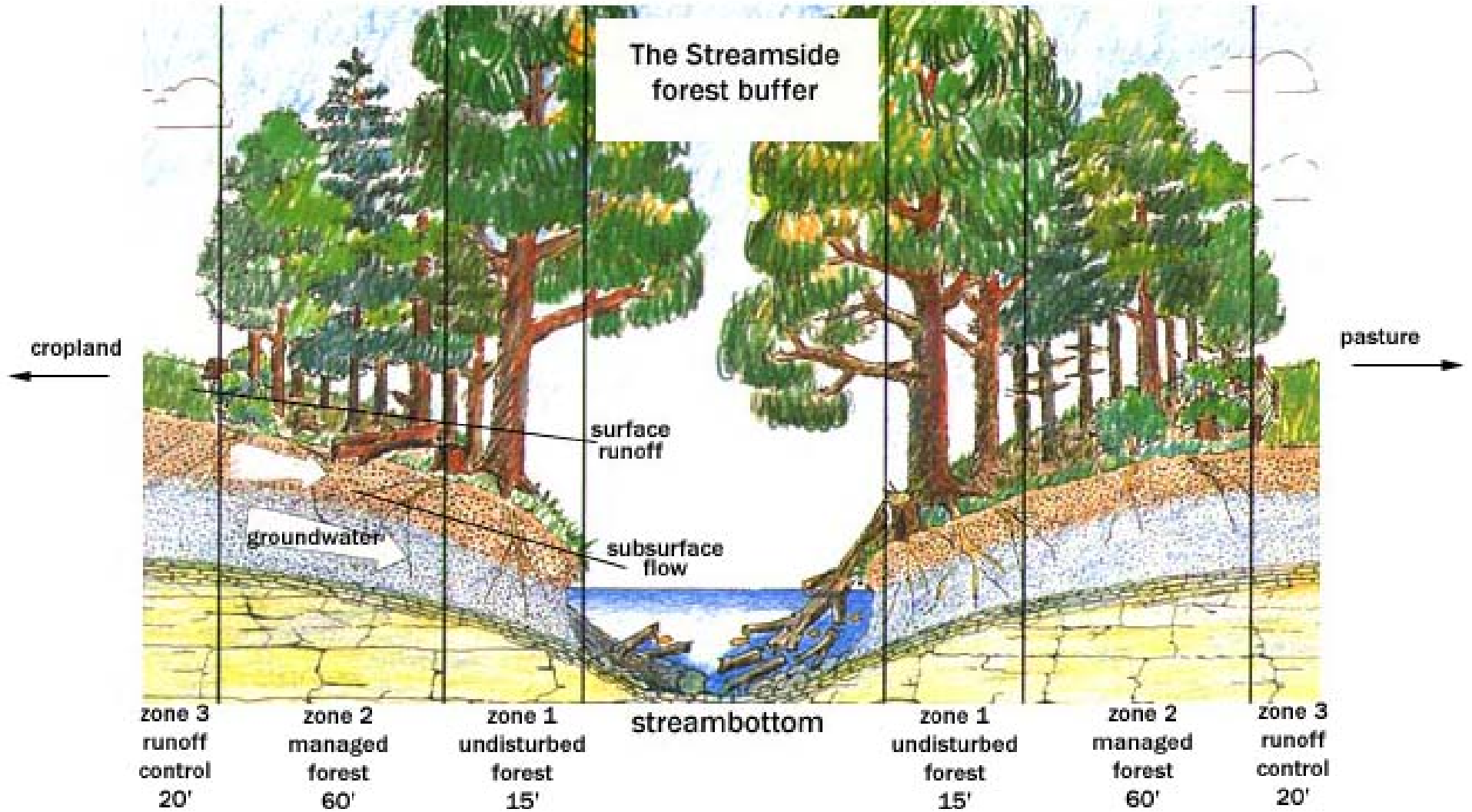
Direction of runoff

Drainage Area


10,098 Gallons

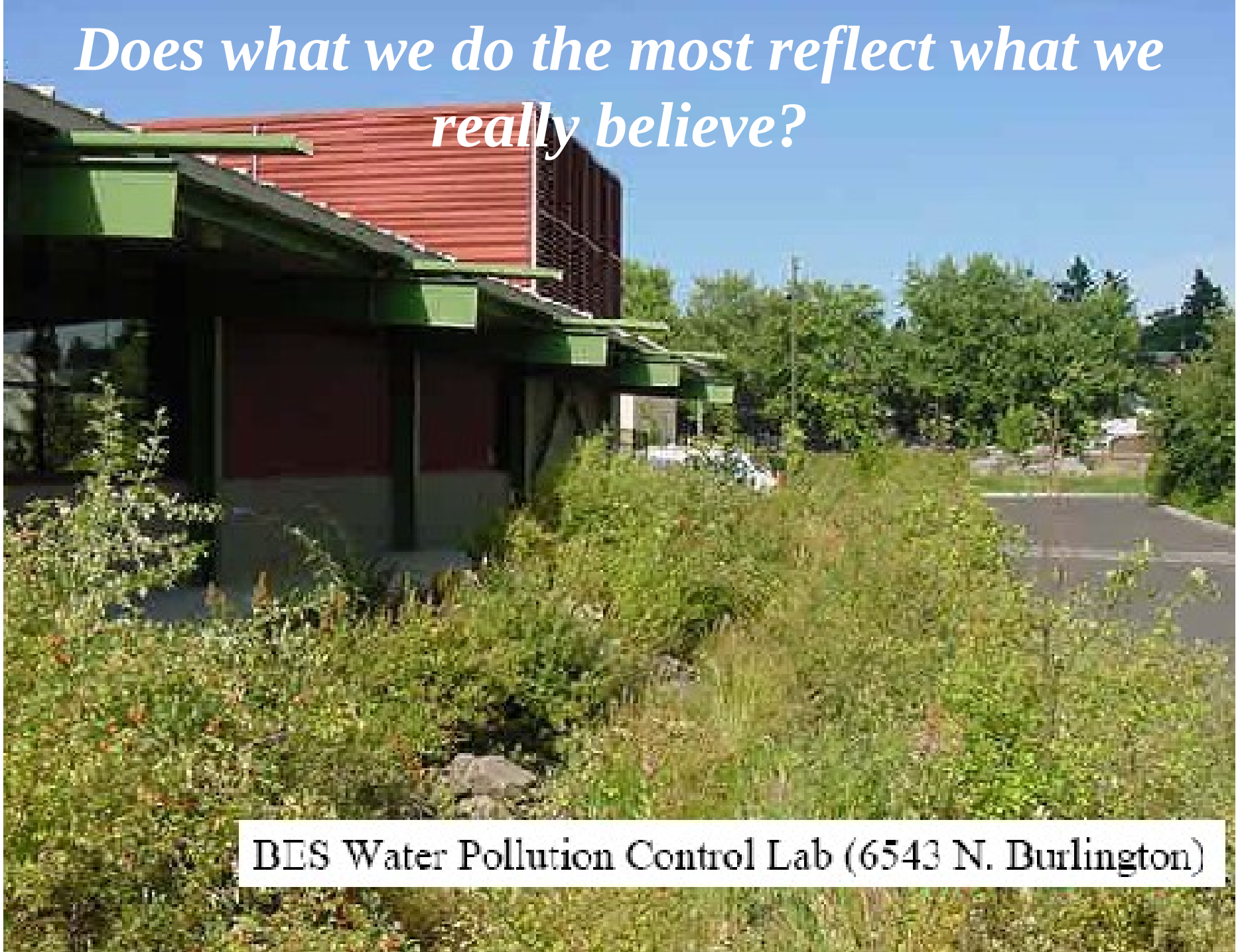

Warm Season Grasses
Wetland

# Creek Banks Need Large, Dense and Wide Forested Buffers

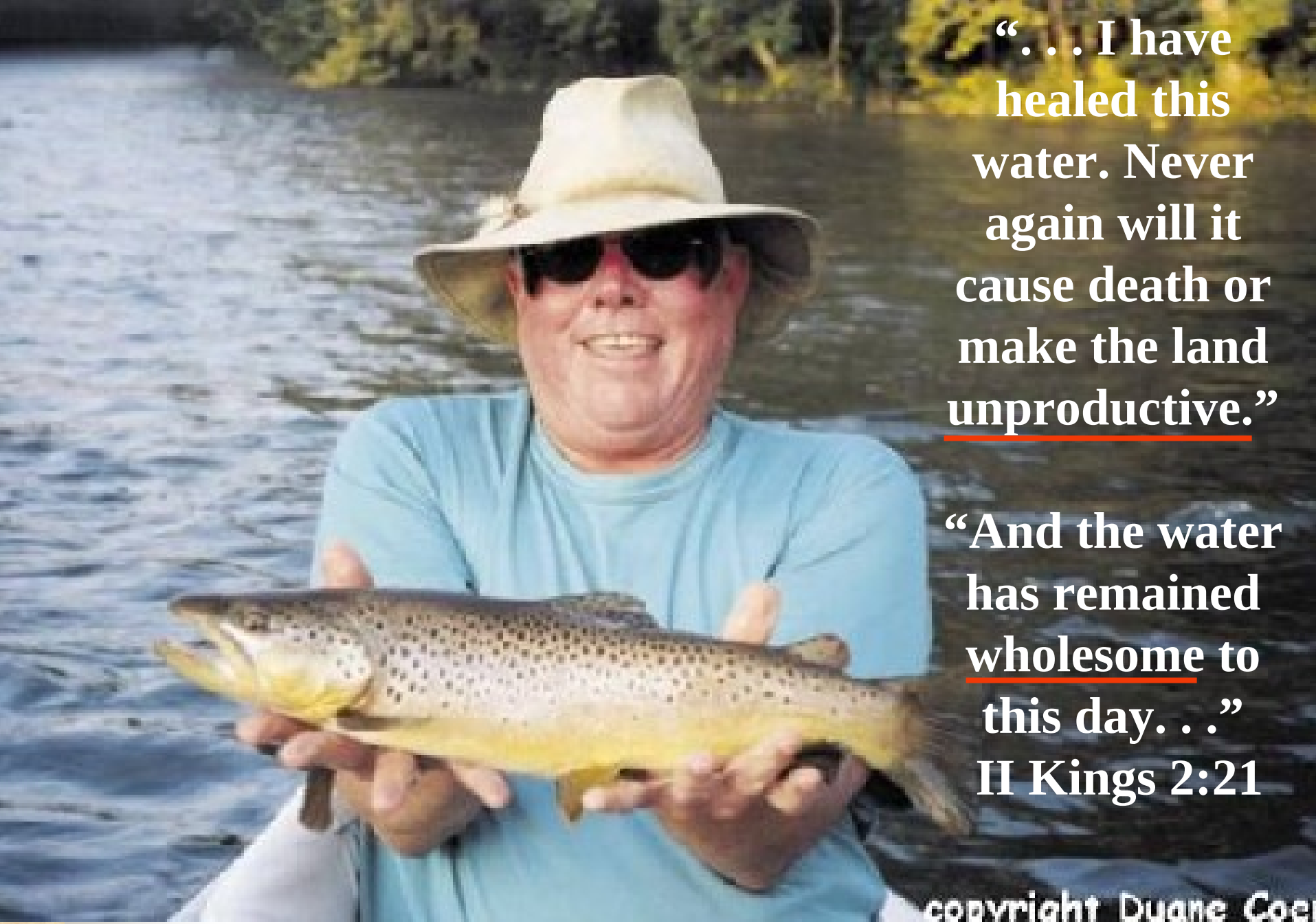



Shade Tolerant
Native Shrubs

# *Does what we do the most reflect what we really believe?*



BES Water Pollution Control Lab (6543 N. Burlington)


". . . I have healed this water. Never again will it cause death or make the land unproductive."
"And the water has remained wholesome to this day. . ."
II Kings 2:21
copyright Duane Coe